SULFUR DIOXIDE AIR QUALITY CHARACTERIZATION PROTOCOL: FACILITIES WARRANTING EVALUATION UNDER THE DATA REQUIREMENTS RULE

AQPSTR 16-08

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Executive Summary

The U.S. Environmental Protection Agency ("USEPA") has promulgated the Data Requirements Rule ("DRR")[1] to support the final phases of implementation of the primary 1-hour sulfur dioxide ("SO_2") National Ambient Air Quality Standard ("NAAQS"). This rulemaking requires regulatory authorities to conduct air quality characterizations (through modeling or monitoring) of facilities with annual emissions meeting or exceeding 2,000 tons (based upon the most recent year of available data), or, alternatively, establishing federally enforceable source emission requirements that will limit a facility's emissions to a level below this threshold.

The Illinois Environmental Protection Agency ("Illinois EPA") is proposing to conduct dispersion modeling to characterize air quality around seven facilities – Kincaid Generation (Kincaid, IL), Rain CII Carbon (Robinson, IL), Midwest Generation (Waukegan, IL), Dynegy Midwest Generation (Baldwin, IL), Prairie State Generating Company (Lively Grove, IL), U.S. Steel Corporation (Granite City, IL), and Gateway Energy & Coke Company (Granite City, IL) – and to provide Primary Quality Assurance Organization ("PQAO") oversight responsibilities for an ambient monitoring program proposed by two other facilities – Archer Daniels Midland Company (Decatur, IL) and Tate & Lyle Ingredients Americas (Decatur, IL) – which will be included in the Agency's 2017 Monitoring Plan. The methodologies and procedures described in this document are provided for USEPA review and comment in partial fulfillment of Illinois EPA's obligations under the DRR.

[1] Data Requirements Rule for the 2010 1-Hour Sulfur Dioxide (SO_2) Primary National Ambient Air Quality Standard (NAAQS); Final Rule, Federal Register, Vol. 80, No. 162, August 21, 2015, p. 51052-51088.

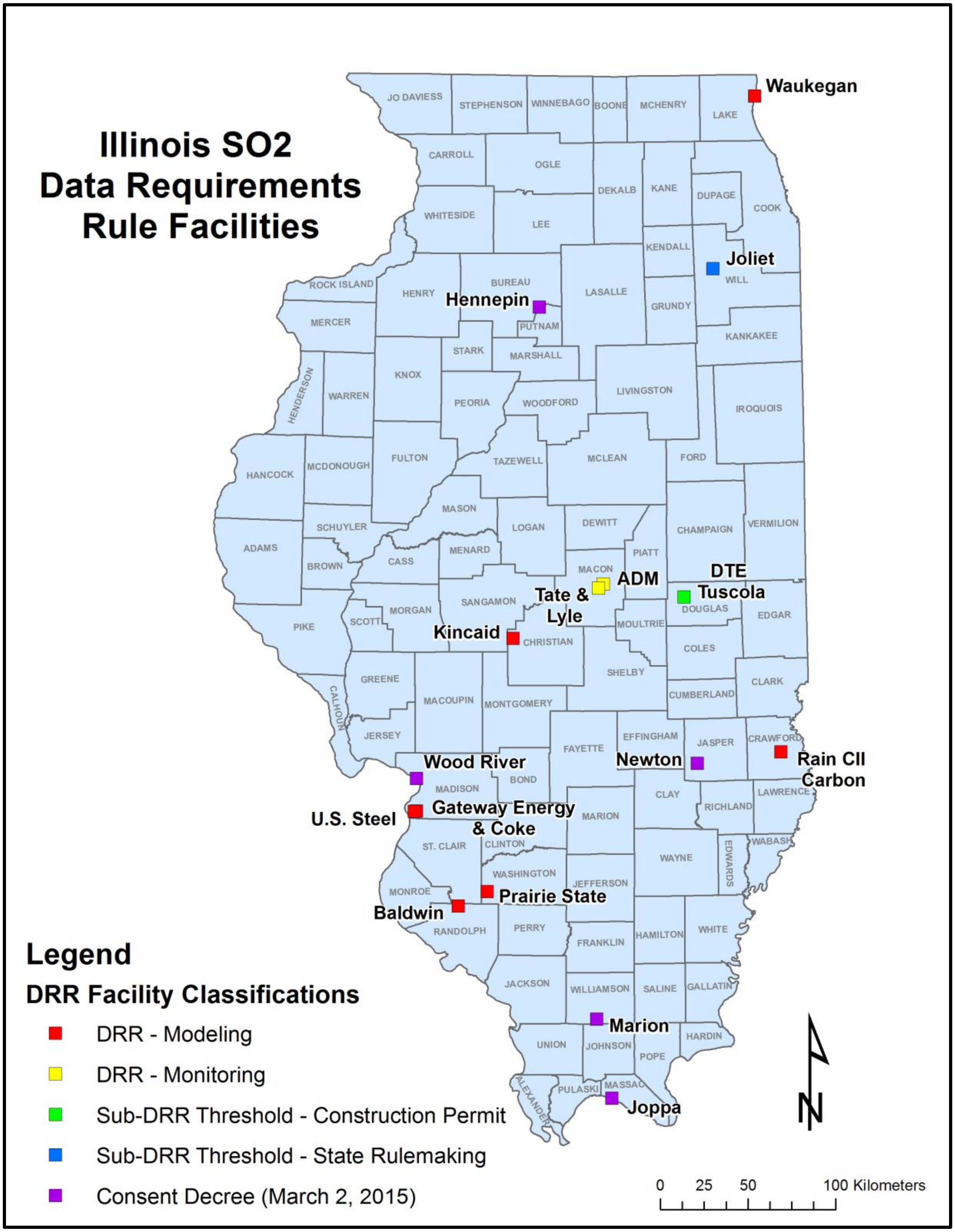
1.0 Introduction/Background

The 1-hour SO_2 NAAQS implementation process is currently on a court-approved schedule[2] for completion of area designations by USEPA in three rounds: the first round by July 2, 2016; the second round by December 31, 2017; and the final round by December 31, 2020. In the court-approved agreement that contains this schedule, USEPA indicated that it would designate two additional groups of areas by July 2, 2016. These include areas that have newly monitored violations of the NAAQS, and secondly, areas "that contain any stationary source that according to the EPA's Air Markets Database either emitted more than 16,000 tons of SO_2 in 2012 or emitted more than 2,600 tons of SO_2 and had an emission rate of at least 0.45 pounds SO_2/mmbtu in 2012 that has not been announced (as of March 2, 2015) for retirement."[3] Illinois had five facilities that met the criteria established in the court order – Hennepin Power Station (Putnam County), Newton Power Station (Jasper County), Joppa Steam Coal Power Plant (Massac County), Marion Power Station (Williamson County), and the Wood River Power Station (Madison County). USEPA is currently finalizing the area designations for these five facilities under the first round of the schedule.

The final implementation phases of the 1-hour SO_2 NAAQS incorporate the December 31, 2017, and December 31, 2020, deadlines agreed to in the March 2, 2015, court order and the closely-linked requirements specified in the DRR. The DRR directs air regulatory authorities to characterize current air quality around sources that emitted greater than 2,000 tons per year ("tpy") in the most recent year for which data is available. Based upon the criteria and conditions set forth in the rule, the Illinois EPA will be characterizing air quality for nine facilities – Kincaid Generation (Kincaid, IL), Rain CII Carbon (Robinson, IL), Midwest Generation (Waukegan, IL), Dynegy Midwest Generation (Baldwin, IL), Prairie State Generating Company (Lively Grove, IL), Archer Daniels Midland Company (Decatur, IL), Tate & Lyle Ingredients Americas (Decatur, IL), and the "single source" consisting of U.S. Steel Corporation and Gateway Energy & Coke Company (Granite City, IL). These facilities are a subset of those that were required to be identified to USEPA this past January (2016).[4] The locations of these facilities are shown on the map provided in Figure 1. Thus, the air quality characterization of DRR facilities, through monitoring and modeling as proposed in this protocol document, will inform and facilitate the area designations process for the second and third rounds of the schedule.

[2] Sierra Club v. McCarthy, No. 3-13-cv-3953 (SI) (N.D. Cal. Mar. 2, 2015).
[3] March 20, 2015 Memorandum from Janet G. McCabe, Acting Assistant Administrator (USEPA) to Lisa Bonnett, Director, Illinois Environmental Protection Agency.
[4] January 12, 2016 letter to Dr. Susan Hedman, Regional Administrator, USEPA Region V, from Lisa Bonnett, Director, Illinois Environmental Protection Agency.

Figure 1
Statewide Map Showing Locations of DRR-Listed Facilities



2.0 Facility Selection

Based upon company-reported actual SO_2 emissions for calendar year 2014, which is the most recent year of certified emissions data available to the Illinois EPA, 15 facilities which exceeded the emissions threshold of 2,000 tons per year were identified for inclusion in the air quality characterization process. As identified earlier, the U.S. Steel Corporation – Granite City Works and Gateway Energy & Coke Company LLC facilities ("U.S. Steel Study Area") are regarded as a "single source" under Clean Air Act Title V permitting, and collectively reported emissions that exceeded the threshold. On January 12, 2016, the Illinois EPA submitted to USEPA Region V a list of facilities for SO_2 air quality characterization, as required under the Data Requirements Rule. It is noteworthy that the DRR stipulates the following: "due to the overlap between the criteria for inclusion of sources in this final rule and those in the March 2015 consent decree, all of the sources identified in the March 2015 consent decree should also be included on the January 2016 list of sources required for characterization under this rule." Thus, the DRR list includes the five electrical generating stations that were modeled under Phase 2 (Illinois Power Generating Company – Newton; Dynegy Midwest Generation LLC – Wood River; Electric Energy, Inc. – Joppa; Dynegy Midwest Generation LLC – Hennepin; Southern Illinois Power Cooperative – Marion), but which will not be further addressed under this modeling protocol.

Additionally, the Midwest Generation LLC – Joliet electrical generating station was modeled in conjunction with the Phase 1 Lemont nonattainment area analysis, though not part of the Lemont nonattainment area. In the R15-21 rulemaking adopted by the Illinois Pollution Control Board and submitted to USEPA as a State Implementation Plan ("SIP") revision, the three units at this facility cannot combust coal on and after December 31, 2016.[5] The conversion from coal combustion to natural gas combustion (with fuel oil backup in the event of natural gas curtailment) will reduce this facility's SO_2 emissions to well below 2,000 tons per year, and thus obviate the need for additional air quality characterization.

Lastly, the DTE Tuscola LLC facility (Tuscola, IL) also appeared on the DRR list because it had reported SO_2 emissions of 9,677 tons in 2014. This cogeneration facility has since ceased burning coal in its boilers. In Illinois Construction Permit #15060039, the coal-firing capability of the three boilers is permanently eliminated, as clearly stipulated in Condition 1.1.5 c: "Beginning January 30, 2016, natural gas, propane, and fuel gas . . . shall be the only fuels fired in the affected boilers." As a result of the reduced SO_2 emissions, the DTE Tuscola LLC facility will not be evaluated for air quality despite appearing on the DRR list.

[5] 35 Illinois Administrative Code 225.296(b)

3.0 Air Quality Characterization: Dispersion Modeling

3.1 General Modeling Methodology

Dispersion modeling to be performed by the Illinois EPA will conform to regulatory procedures described in *The Guideline on Air Quality Models*[6] and recommended practices identified in the draft *SO_2 NAAQS Designations Modeling Technical Assistance Document*[7] ("TAD"). The AERMOD modeling system (which includes the AERMOD dispersion model, the AERMAP terrain preprocessor, and the AERMINUTE and AERMET meteorological preprocessors) will be used to simulate ambient impacts from the DRR facilities. AERMOD is the preferred software for use in regulatory applications, and is particularly suitable for this specific set of air quality analyses given the terrain, stack to structure relationships, dispersion environment, and available meteorological data. AERMOD (version 15181) will be run exclusively in the regulatory default mode. The most recent three years (2013-2015) of meteorological data determined to be representative of a facility's airshed will be used in combination with surface characteristics data obtained from AERSURFACE (version 13016) for simulating the area's planetary boundary layer turbulence structure.

Illinois EPA staff will prepare detailed site characterizations of each DRR facility to support development of specific AERMOD inputs. Building-induced plume downwash will be addressed for all stacks not constructed to a height representing Good Engineering Practice stack height. The Illinois EPA will use USEPA's Building Profile Input Program with PRIME algorithm (BPIPPRM, dated 04274) to determine building parameters to model building wake effects. A relatively standard approach to receptor network design, consisting of discrete fenceline receptors (spaced at approximately 50 meter intervals) and a gridded receptor array extending outward to as much as 26 kilometers from the facility, will be integral to each area-specific analysis.

3.1.1 Modeling Domains and Emission Source Inventories

Modeling domains are proposed based upon the guidance provided in the draft modeling TAD and the professional judgment of Illinois EPA modeling staff. The proposed domains reflect the following considerations: 1) the locations of the DRR-listed facility and potentially significant "near-field" SO_2 emission sources, 2) stack heights, emission rates, and related plume release characteristics, 3) the location and likely extent of significant concentration gradients of nearby sources, and 4) receptor coverage and density that is sufficient to adequately capture and resolve model-predicted maximum SO_2 concentrations. The modeling domains represent the geographic extent of possible emission source inclusion, and are circular constructs with radii ranging in size from 15 - 50 kilometers. These domains are centered on the respective DRR facilities, with the exception of the combined domain that includes the Dynegy Midwest Generation – Baldwin power

[6] 40 CFR Part 51, Appendix W.
[7] SO_2 NAAQS Designations Modeling Technical Assistance Document (draft), February 2016, USEPA (OAR/OAQPS/AQAD), Research Triangle Park, NC.

plant and the Prairie State Generating Company power plant. Since areas of significant impact are not expected to occur at distances representing the furthest extent of the modeling domains, all of the proposed receptor networks are of smaller geographic coverage than the full modeling domains.

The Illinois EPA has formally requested hourly-specific emission rates and stack parameter data for 2012-2015 from both DRR and selected background facilities to best represent ambient loadings in the study area and to obtain the best possible time-resolved estimates for modeling years 2013-2015 or, alternatively, years 2012-2014. Depending upon source and stack monitoring requirements, hourly-specific data may not have been available for certain process sources. In the absence of such data, estimates will be derived from production information (including fuel usage/throughput quantities), reported operational periods, stack test information, and/or other data sources.

The Illinois EPA will rely upon annual emission reports and other information in its Integrated Comprehensive Environmental Management System ("ICEMAN") statewide database to supplement the information provided in response to the DRR data requests. Some data has been provided by USEPA and the Indiana Department of Environmental Management ("IDEM") in response to specific requests.

Most sources to be modeled represent point sources, including flares, but for some of the facilities, selected releases are represented as an area source or as volume sources. Point source stack configurations are typically vertical with unobstructed releases, but there are some stacks with "raincaps," and other stacks that represent horizontal releases. For the latter, each source's exit velocity will be adjusted in the manner recommended in the *AERMOD Implementation Guide*.[8] This guidance document specifically indicates that the "user should input the actual stack diameter and exit temperature but set the exit velocity to a nominally low value, such as 0.001 m/s." Flares will be modeled with adjusted release parameters, consistent with current modeling guidance. The adjusted parameters include fixed values for temperature (1273 degrees Kelvin) and exit velocity (20 meters/second) and modified values for release height and diameter. The *AERSCREEN User's Guide*[9] provides the equation for calculating the effective flare height:

$$H_{sl} = H_s + 4.56 \times 10^{-3} \, (H_r/4.1868)^{0.478}$$

where,

H_{sl} = effective flare height (meters)
H_s = stack height above ground (meters)
H_r = total heat release rate (Joules/second)

[8] AERMOD Implementation Guide. 2009. U.S. Environmental Protection Agency, Research Triangle Park, NC.
[9] AERSCREEN User's Guide. EPA-454/B-11-001. U.S. Environmental Protection Agency, Research Triangle Park, NC.

The screening modeling documentation also provides an equation for calculating the effective diameter for the flare:

$$D = 9.88 \text{ x } 10^{-4} \text{ x } [HR \text{ x } (1\text{-}HL)]^{0.5}$$

where,

D = effective stack diameter (meters)
HR = heat release rate (calories/second)
HL = heat loss fraction [used default value of 0.55]

3.1.2 Terrain Processing (AERMAP)

Procedures for selecting and processing terrain data are provided by the *User's Guide for the AERMOD Terrain Preprocessor* (AERMAP),[10] and the March 2011 *AERMAP User's Guide Addendum* (version 11103).[11]

Selection of terrain data corresponds to the geographic areas represented by the modeling domains. U.S. Geological Survey ("USGS") National Elevation Dataset ("NED") input data will be used for all DRR modeling. The latest NED data have been obtained in TIFF format directly from the USGS for the individual study areas. This data format is compatible for use with AERMAP. The final NED TIFF files have a resolution of one-third arc second (10 meters) and the data is stored in a Geographic (latitude/longitude) coordinate system based on the North American Datum of 1983 ("NAD83"). Conversions from latitude/longitude to Universal Transverse Mercator ("UTM") coordinates take place within AERMAP using the UTMGEO program. NADCON conversion software (version 2.1) is incorporated to calculate datum shifts, where necessary. AERMAP (version 11103) will be run within the BEEST for Windows software. Elevations from the NED data will be determined for all sources and structures, and both elevations and representative hill heights will be determined for receptors. This data will be subsequently input to AERMOD.

3.1.3 Meteorological Data (AERSURFACE/AERMINUTE/AERMET)

3.1.3.1 Meteorological Data Selection

Procedures for selecting and developing meteorological data have been provided in the draft document *Regional Meteorological Data Processing Protocol, EPA Region 5 and States*.[12] Within this document, content pertaining to selection criteria for surface meteorological data addresses the representativeness of meteorological data collection sites to the emission source/receptor impact area.

[10] User's Guide for the AERMOD Terrain Preprocessor (AERMAP). EPA-454/B-03-003, October 2004. U.S. Environmental Protection Agency, Research Triangle Park, NC.
[11] Addendum – User's Guide for the AERMOD Terrain Preprocessor (AERMAP). EPA-454/B-03-003 (October, 2004). U.S. Environmental Protection Agency, Research Triangle Park, NC.
[12] Draft – Regional Meteorological Data Processing Protocol. EPA Region 5 and States. August 2014.

There are two criteria to be considered: 1) the suitability of meteorological data for the study area, and 2) the actual similarity of surface conditions and surroundings at the emission source/receptor impact area compared to the location of the meteorological instrumentation tower. The closest National Weather Service ("NWS") surface meteorological data station is believed to be the most acceptable for most modeling domains (the use of Milwaukee NWS data for the Midwest Generation – Waukegan Study Area is an exception to this general approach). Similarly, upper air data for processing with surface meteorological data will be chosen on the basis of regional representativeness.

3.1.3.2 Meteorological Data Preprocessing

Procedures for processing meteorological data are provided in the *2004 User's Guide for the AERMOD Meteorological Preprocessor* (AERMET)[13] and in the 2014 AERMET User's Guide Addendum.[14] AERMET (version 15181) processes raw meteorological data to produce higher order data that can be read by the AERMOD model. The first two stages of processing the raw data involve QA/QC of the meteorological data and then correlating the surface data with upper air data. While standard NWS surface data include meteorological data records recorded near the beginning of each hour, additional wind speed and wind direction data recorded at one minute intervals were also included in the development of higher order meteorological data. Automated Surface Observing System ("ASOS") 1-minute wind data obtained for NWS surface stations were processed using AERMINUTE (version 15272), as specified in the companion *AERMINUTE User's Instructions*.[15,16] A third and final stage reads the merged surface and upper air data file and processes surface characteristics data at the tower site for final generation of meteorological files to be read into the AERMOD modeling runs.

The surface conditions data are provided through another preprocessor called AERSURFACE, and processing was conducted consistent with documentation in the *AERSURFACE User's Guide*.[17] AERSURFACE is a tool using land cover data around the meteorological tower site to principally determine surface roughness by wind sector. A wind sector is defined by a wedge shaped area extending from the tower out to one kilometer, but not exceeding 30 degrees in angular width. The total circular area will have no more than 12 sectors. Two other parameters, Bowen ratio and albedo, are determined more on a regional basis, also based on land cover. All three factors can change with the seasons, as well as on a monthly basis. Meteorological conditions vary from year to year, resulting in periods that can be abnormally dry one year, and wet the following year, or simply

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[13] User's Guide for the AERMOD Meteorological Preprocessor (AERMET). 2004. EPA-454/B-03-002. U.S. Environmental Protection Agency, Research Triangle Park, NC.
[14] Addendum – User's Guide for the AERMOD Meteorological Preprocessor (AERMET). EPA-454/B-03-002 (November, 2014). U.S. Environmental Protection Agency, Research Triangle Park, NC.
[15] AERMINUTE User's Instructions (Draft). 2011. U.S. Environmental Protection Agency, Research Triangle Park, NC.
[16] AERMINUTE User's Instructions. 2014. U.S. Environmental Protection Agency, Research Triangle Park, NC.
[17] Revised – AERSURFACE User's Guide (Revised January 16, 2013). EPA-454/B-08-001 (January, 2008). U.S. Environmental Protection Agency, Research Triangle Park, NC.

exhibiting average conditions. In augmenting Stage 3 parameters to accommodate monthly variability, the Illinois EPA has calculated values for albedo, Bowen ratio, and surface roughness on a monthly basis in order to provide greater temporal resolution in the characterization of surface moisture and in capturing the influence of snow cover. Thus, AERSURFACE has been run in a monthly format for wet, dry, and average moisture conditions for both snow cover and no snow cover.

Determinations regarding snow cover are based upon Local Climatological Data ("LCD") from the National Weather Service surface collecting station. The LCD indicates which individual days had snow cover and the snow depth for that particular day. Days with greater than a trace amount of snow are considered to have snow cover. The fraction of days per month with snow cover will be multiplied by the value for snow cover applicable to albedo and surface roughness values. This approach will also be implemented for values involving no snow cover. The computed values will be added and then divided by the number of days in a particular month. The end result is an averaged value for each month for regional albedo and surface roughness by wind sector. These calculations were produced through a spreadsheet, as are the ones described below.

With regard to moisture levels, the determination of a "wet" or "dry" recent year has been made based upon what was known about precipitation records over historical periods of time that might range over 50 or more years. Generally, an average for each month will be calculated over 30 years of data. A dry month is considered to be that month where the monthly total was at or below 0.6 times the average. A wet month would be a month where the monthly total of precipitation would be at or over 1.2 times the average. Months within 0.6 to 1.2 times the average precipitation were considered to be normal or average. These ratios were determined from guidelines set forth in the AERSURFACE User's Guide. According to this document, a dry month can be considered to be that month where the monthly precipitation total falls under the lower 30th percentile of monthly records. A wet month can be a month where the monthly total of precipitation would be above the upper 30th percentile of monthly records. An average month would fall in between the lower and upper 30th percentiles. Months evaluated as being "dry" used the Bowen ratio that was determined for a "dry" month from the AERSURFACE runs. Likewise, "wet" and "average" months determined from the LCD data were linked to corresponding output in the AERSURFACE runs. For winter months, after the evaluation of monthly moisture is made, the Bowen Ratio is additionally averaged for days of snow cover in the same way as albedo.

In general, typical monthly values for albedo can be affected by the presence of snow but not by moisture. Similarly, surface roughness can be influenced by snow, but not by moisture. Monthly values for Bowen ratio can be influenced by snow cover and moisture.

Surface meteorological data used by AERMET are obtained from multiple sources. Hourly surface meteorological data records are read by AERMET that include all the necessary elements for meteorological data processing, including wind direction and wind speed. Wind data taken at hourly intervals may not always portray wind conditions for the entire hour, which can be variable in nature compared to more stable meteorological properties not susceptible to wide-ranging changes. Wind data that portray calm conditions for particular hours are not usable for modeling purposes, and must be passed over by AERMOD when modeling is being performed. In order to better represent actual wind conditions at the meteorological tower, wind data of one-minute duration will be obtained for the same meteorological tower but in a different formatted meteorological file, and processed using AERMINUTE. These data shall subsequently be integrated into the AERMET meteorological data processing to produce final hourly wind records that more closely approach actual conditions at the meteorological tower, with fewer calm wind conditions. This allows AERMOD to apply more hours of meteorology and thereby process more pollutant concentration values when generating final output.

As a guard against excessively high concentrations that could be produced in very light wind conditions, a minimum threshold of 0.5 meters/second in processing meteorological data for use in AERMOD will be applied so that no wind speeds lower than this would be used for determining concentrations.[18] This threshold will be specifically applied to the one-minute wind data.

3.1.4 Model Implementation (AERMOD)

AERMOD (AMS/EPA Regulatory Model) is the preferred Gaussian plume dispersion model for steady state air pollutant modeling, and the Illinois EPA will be relying upon AERMOD (version 15181) and companion User Guide documentation[19] and recent Addendum[20] in developing its air quality characterizations and designation recommendations for the areas surrounding the DRR facilities. Regulatory default options will be implemented, consistent with established practices for use of AERMOD in regulatory applications.

3.1.4.1 Dispersion Environment (Rural/Urban Determination)

The urban or rural dispersion regime of emissions sources is a critical parameter in properly characterizing dispersion in the boundary layer. Generally, urban areas cause higher rates of dispersion because of increased turbulence and buoyancy, the result of higher surface roughness and enhanced thermal buoyancy from urban heat island effects. The manner in which emissions disperse downwind from short stacks as compared to tall stacks can differ substantially between urban and rural environments due to significant differences in land use and surface roughness features.

The recommended methodology for making a rural or urban determination for a study area, or more localized application, is outlined in Section 7.2.3 (c, d, e) of 40 CFR Part 51 Appendix W, as well as in the AERMOD Implementation Guide (p. 14-16). These documents reference two methodologies

[18] Use of ASOS meteorological data in AERMOD dispersion modeling. Tyler Fox Memorandum dated March 8, 2013. U.S. Environmental Protection Agency, Research Triangle Park, NC.
[19] User's Guide for the AMS/EPA Regulatory Model – AERMOD. 2004. EPA-454/B-03-001. U.S. Environmental Protection Agency, Research Triangle Park, NC.
[20] Addendum – User's Guide for the AMS/EPA Regulatory Model – AERMOD. 2014. EPA-454/B-03-001 (September, 2004). U.S. Environmental Protection Agency, Research Triangle Park, NC.

as acceptable approaches for making the urban/rural determination. The first approach is the land use type method described by Auer.[21] The second recommended approach is to use population density.

Auer's methodology recommends categorizing an area as urban or rural based on existing land use types. This method bases the urban/rural determination on predominant land use types within a study area (for an individual facility, typically a three-kilometer radius is considered sufficient). If 50% of the study area is comprised of urban land use types, then the source lying within this area should be modeled as urban. If land use in the study area is less than 50% urban, then the rural option is recommended. Table 1 identifies the land use types that signify urban and rural land use per Auer's study.

Table 1
Auer's Land Use Classification Scheme

Type Identifier	Description/Use	Urban or Rural
I1	Heavy Industrial	Urban
I2	Light-Moderate Industrial	Urban
C1	Commercial	Urban
R2/R3	Compact Residential	Urban
R1	Common Residential	Rural
R4	Estate Residential	Rural
A1	Metropolitan Natural Areas	Rural
A2	Agricultural/Crops	Rural
A3	Undeveloped Land (Wild Grasses)	Rural
A4	Undeveloped Rural (Heavily Wooded)	Rural
A5	Water Surfaces (Rivers, Lakes)	Rural

The population density method uses a threshold of 750 people per square kilometer, based on census data, as the determinant of urban or rural. If the population is higher than 750 per square kilometer (usually in a three-kilometer radius around a source) within the study area, then it is likely an urban environment. This method is not considered as robust as an Auer's land use analysis.

For purposes of the DRR air quality modeling, an Auer's land use analysis was performed on the full extent of each modeling domain, as well as on the subdomain areas comprising a three-kilometer radius centered on each facility or facility grouping (U.S. Steel/Gateway Energy & Coke Company). These analyses were conducted using the 2011 National Land Cover Data ("NLCD") database. The data were obtained from the Multi-Resolution Land Characteristics Consortium, or MRLC (www.mrlc.gov/nlcd2011.php). The NLCD 2011 database categorizes land cover into 20 different

[21] Auer, Jr., A.H. (1978). Correlation of Land Use and Cover with Meteorological Anomalies. Journal of Applied Meteorology, 17(5), 636-643.

types at a 30-meter grid cell resolution. These categories were further refined and allocated as indicated in Table 2 to match the 12 land use categories referenced in Auer's classification scheme.

Table 2
Land Cover Mapping from NLCD to Auer's Classifications

Code	NLCD 2011 Description	Auer's Code	Auer's Classification
11	Open Water	A5	Rural
21	Developed, Open Space	A1/R4	Rural
22	Developed, Low Intensity	R1	Rural
23	Developed, Medium Intensity	R2/R3	Urban
24	Developed, High Intensity	I1/I2/C1	Urban
31	Barren Land (Rock/Sand/Clay)	A3	Rural
41	Deciduous Forest	A4	Rural
42	Evergreen Forest	A4	Rural
43	Mixed Forest	A4	Rural
52	Shrub/Scrub	A4	Rural
71	Grassland/Herbaceous	A3	Rural
81	Pasture/Hay	A3	Rural
82	Cultivated Crops	A2	Rural
90	Wood Wetlands	A4	Rural
95	Emergent Herbaceous Wetlands	A3	Rural

Illinois EPA has been utilizing Geographic Information System software to extract, tabulate, and map the percentages of urban and rural land cover per Auer's classification scheme for the modeling study areas and for the DRR facility-centered near-field areas with radii of three kilometers.

3.1.4.2 Monitored Background

Modeling for air quality characterizations and area designation recommendations will be based upon design values of cumulative concentrations from discretely modeled sources and monitored background concentrations. The hourly by season background concentrations will be input to AERMOD using the "BACKGRND" keyword and "SEASHR" parameter on the Source Pathway in the model runstream file. Full implementation of this option requires that the "BACKUNIT" keyword and "BGunits" parameter option of micrograms per cubic meter ("UG/M3") be specified, while also indicating the "SrcIDs" of "ALL" and "BACKGROUND" with the "SRCGROUP" keyword. There are 24 separate "SEASHR" values input for each of the four seasons, for a total of 96 monitored concentrations. Each of these values represents a three-year average (2013-2015, or alternatively 2012-2014) of the second highest hourly concentration (for each hour of the day) for each season. AERMOD will read these values from the runstream file and then incorporate into the final predicted concentration the background value corresponding to the season and hour modeled.

In the USEPA memorandum from Stephen D. Page entitled *Guidance Concerning the Implementation of the 1-hour SO_2 NAAQS for the Prevention of Significant Deterioration Program,*[22] the text addressing the use of monitored background concentrations in combination with modeled concentrations for comparison to the NAAQS is non-prescriptive on the topic. It does state that a conservative approach that would "add the overall highest hourly background SO_2 concentration from a representative monitor to the modeled design value" could be "applied without further justification." Illinois EPA will apply a methodology that derives from the USEPA memorandum by Tyler Fox entitled, *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard*.[23] In reference to combining modeled results and monitored background to determine compliance, the narrative states that "an appropriate methodology for incorporating background concentrations in the cumulative impact assessment" for the one-hour SO_2 standard "would be to use multiyear averages" of the 99th-percentile "of the available background concentrations by season and hour-of-day." An associated footnote succinctly states the monitored values to be used: "For 1-hour SO_2 analyses, use the 2nd-highest value for each season and hour-of-day combination or the 4th-highest value for hour-of-day only." The seasonal, hourly-averaged 2013-2015 SO_2 background values for the DRR modeling analyses will be developed for monitors in East St. Louis, Nilwood, and Oglesby. The proposed values are provided in Appendix B.

3.1.4.3 Model Execution and Output Evaluation

When using modeling, the one-hour primary SO_2 NAAQS is attained when the highest five-year average of the fourth high maximum daily one-hour average concentration (by receptor) is less than or equal to 75 ppb. Since AERMOD generates output concentrations in micrograms per cubic meter, in order to assure ease of comparison of model output to the NAAQS, the level of the standard (75 ppb) was converted to micrograms per cubic meter based on the ideal gas law at standard temperature (68 degrees Fahrenheit) and pressure (1 atmosphere), as follows:

$$\text{Concentration } (\mu g/m^3) = [SO_2 \text{ Molecular Weight x Concentration (ppm)}] / 0.02445$$

$$= [(64) \text{ x } (0.075)]/(0.02445)$$

$$= 196.32\ \mu g/m^3$$

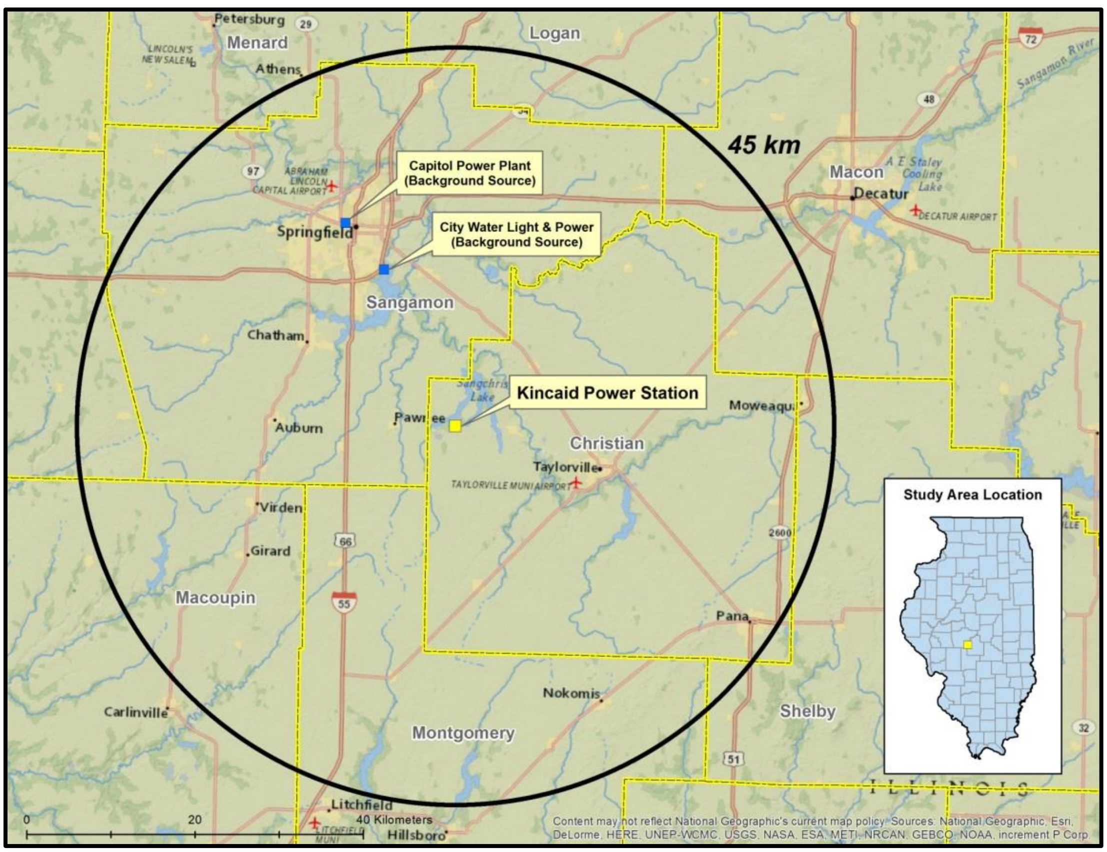
[22] Guidance Concerning the Implementation of the 1-hour SO_2 NAAQS for the Prevention of Significant Deterioration Program. Stephen D. Page memorandum dated August 23, 2010, Research Triangle Park, NC.
[23] Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard. Tyler Fox memorandum dated March 1, 2011. U.S. Environmental Protection Agency, Research Triangle Park, NC.

3.2 Facility-Specific Modeling Assessments

3.2.1 Kincaid Generation LLC

Kincaid Generation LLC (Kincaid) operates an electrical power generating station approximately four miles west of the town of Kincaid, along the southern end of Sangchris Lake in northwestern Christian County (see Figure 2). The facility produces electricity from two coal-fired cyclone boilers with nominal capacities of 6,634 and 6,406 mmBtu/hour. SO_2 emissions are controlled through dry sorbent injection of either trona (sodium carbonate) or sodium bicarbonate in conjunction with electrostatic precipitators, with the controlled emissions subsequently routed to a single common stack. A natural gas-fired auxiliary boiler, with a nominal capacity of 175 mmBtu/hour, is used to provide heat to the plant and to generate steam during certain startups of the coal-fired boilers.

Figure 2
Kincaid Generation Study Area



3.2.1.1 Proposed Modeling Domain and Receptor Network

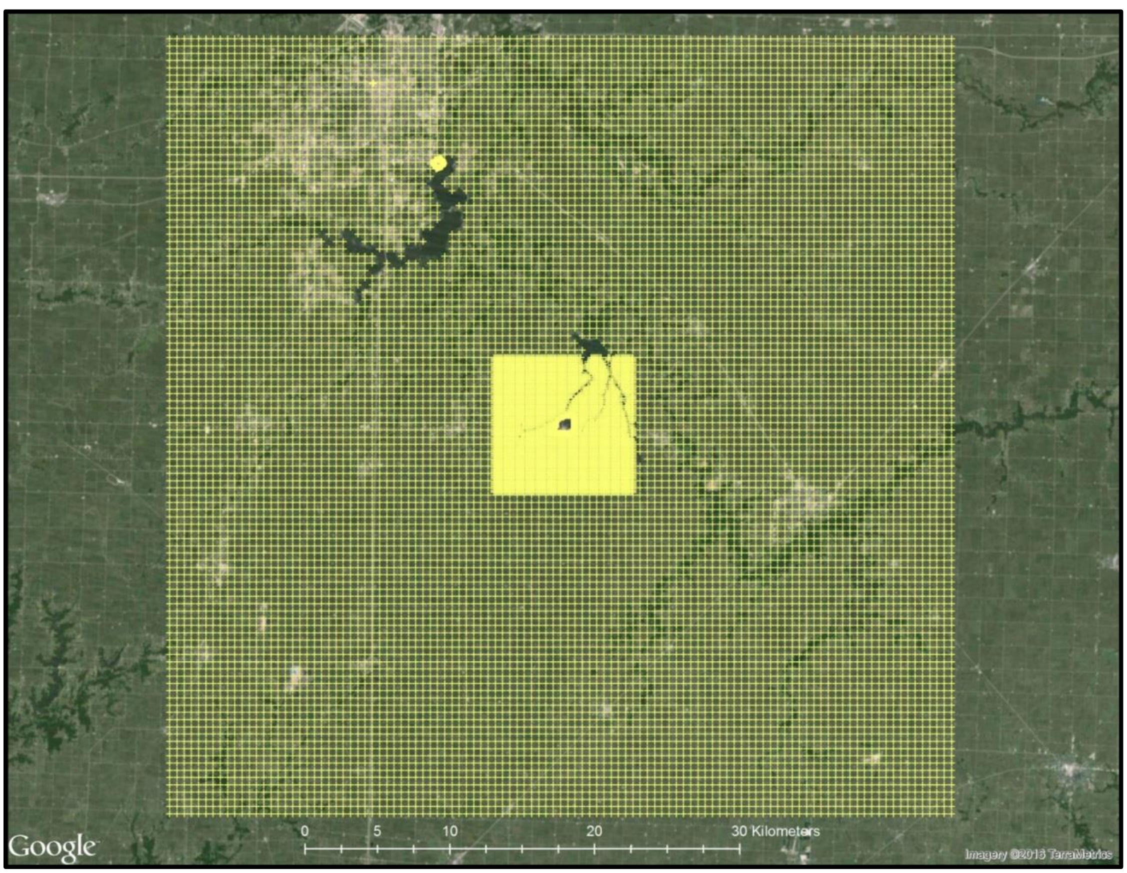
The air quality characterization of the Kincaid facility and surrounding area will use a modeling domain centered on Kincaid's main boiler stack and include regional emissions sources within a 45-

kilometer radius of that centroid. The study area terrain is best characterized as flat to gently rolling. Only two facilities, located in adjoining Sangamon County – City of Springfield's City Water Light & Power Station ("CWLP") and Illinois Secretary of State's Capital Power Plant ("CPP") – will be discretely modeled along with the Kincaid sources. To ensure adequate capture of predicted maximums near the DRR facility, as well as for two the background sources, the proposed receptor network is as follows:

- 50 meters along the fenceline (Kincaid, CWLP, CPP)
- 100 meters from the Kincaid fenceline out to a distance of approximately four kilometers
- 500 meters from four kilometers out to a distance of approximately 26 kilometers from Kincaid.

The Kincaid Study Area receptor network consists of 19,862 receptors, and covers large portions of Christian and Sangamon Counties, and the northeast section of Macoupin County (See Figure 3). Per the recommendation of the TAD, receptors were not placed on large bodies of water (Lake Springfield, Sangchris Lake).

Figure 3
Receptor Grid – Kincaid Study Area



3.2.1.2 Auer's Analysis (Urban/Rural Environment)

An Auer's analysis, as discussed in Section 3.1.4.1 was applied to the Kincaid Study Area. The 45-kilometer radius study area and a three-kilometer near-field ring, centered on the main stack at Kincaid, were evaluated for determining whether the areas are predominantly urban or rural land cover environments. The results of the Auer's analysis are presented in Figures 4 and 5 and Table 3.

Figure 4
Land Cover in the Kincaid Study Area (Urban vs. Rural)

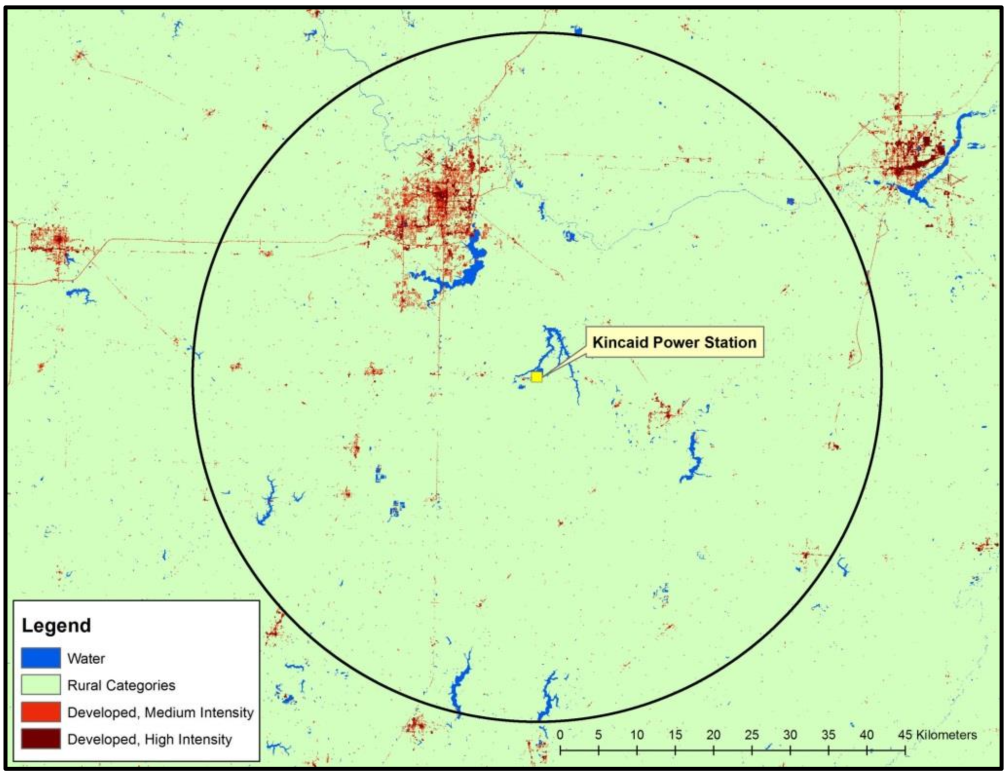


Figure 5
Land Cover within a Three-Kilometer Radius of Kincaid Generation (Urban vs. Rural)

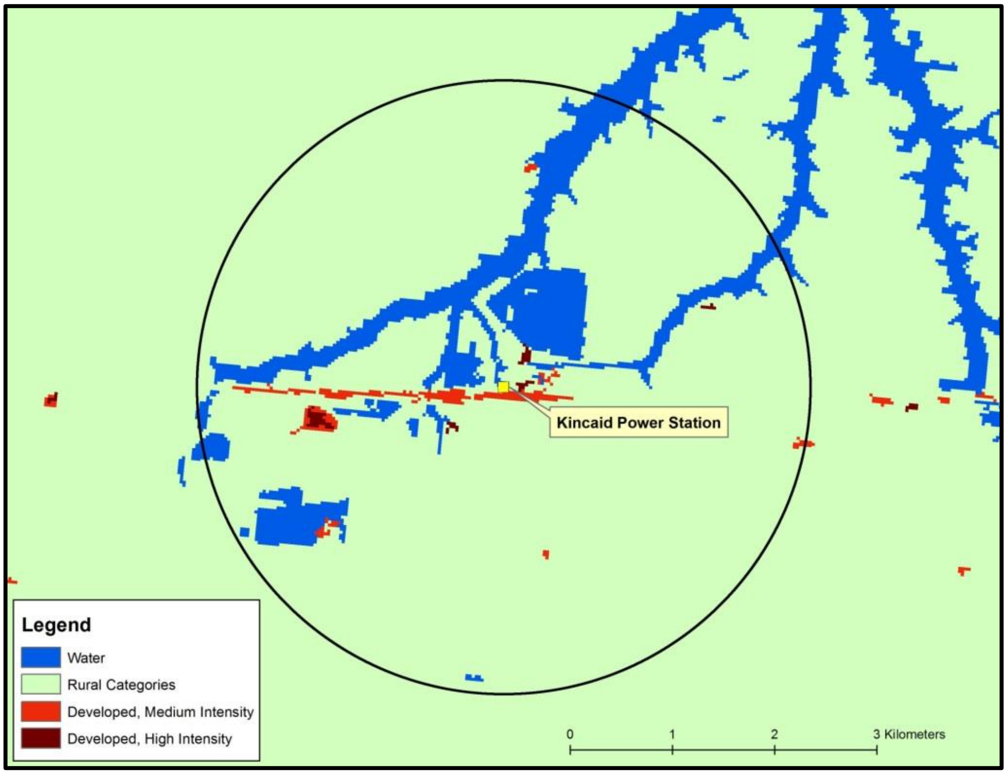


Table 3

Land Cover Percentages by Auer's Category for a Three-Kilometer Radius Area and for the Modeling Domain (45-Kilometer Radius) – Kincaid Study Area

Kincaid Study Area Auer's Analysis				Auer's 3 km Ring			Study Area 45 km Ring		
NLCD Value	NLCD 2011 Description	Auer's Code	Auer's Class	Cell Count	Percentage	Totals	Cell Count	Percentage	Totals
23	Developed, Medium Intensity	R2/R3	Urban	323	1.01%	1.23%	96,746	1.34%	1.65%
24	Developed, High Intensity	I1/I2/C1		72	0.23%		21,880	0.30%	
11	Open Water	A5	Rural	3,422	10.70%	98.77%	71,820	1.00%	98.35%
21	Developed, Open Space	A1/R4		786	2.46%		311,290	4.33%	
22	Developed, Low Intensity	R1		848	2.65%		289,462	4.02%	
31	Barren Land (Rock/Sand/Clay)	A3		42	0.13%		2,838	0.04%	
41	Deciduous Forest	A4		3,148	9.84%		489,066	6.80%	
42	Evergreen Forest	A4		0	0.00%		121	0.00%	
43	Mixed Forest	A4		0	0.00%		9	0.00%	
52	Shrub/Scrub	A4		0	0.00%		301	0.00%	
71	Grassland/Herbaceous	A3		292	0.91%		11,867	0.16%	
81	Pasture/Hay	A3		1,044	3.26%		337,121	4.68%	
82	Cultivated Crops	A2		21,990	68.73%		5,508,283	76.53%	
90	Wood Wetlands	A4		17	0.05%		55,369	0.77%	
95	Emergent Herbaceous Wetlands	A3		9	0.03%		1,033	0.01%	
Analysis based on 30 meter by 30 meter raster cells extracted for each area.			*Total*	*31,993*	*100.00%*	*100.00%*	*7,197,206*	*100.00%*	*100.00%*

The Auer's analysis indicates that the study area and near-field are both at least 98% rural; therefore Illinois EPA intends to employ the rural option to all emissions sources in the modeling domain.

3.2.1.3 Emissions

As described in Section 3.1.1, USEPA modeling guidance recommends the use of actual emissions (in contrast to allowable emissions) in generating model output to represent air quality in the study area. Illinois EPA has acquired the best available emissions data for the three facilities to be modeled in this study area and will work to develop an hourly emissions characterization profile based on the most recent three years of actual emissions for each of these facilities.

Dynegy Midwest Generation Inc. ("DMG") is the current owner of the Kincaid Generation LLC facility. The company has provided hourly-specific SO_2 emission rates for Boiler #1, Boiler #2, and the Auxiliary Boiler for calendar years 2012-2015. Total actual emissions reported by the facility for years 2013-2015 are provided in Table 4, together with those emissions reported for the CWLP and CPP plants.

The CWLP power plant is approximately 21 kilometers northwest of the Kincaid power plant. Though the magnitude of CWLP's 2014 emissions (1,203 tons) was approximately 43% of that of Kincaid Generation's emissions (2,818 tons), the potential for plume interaction that would result in significant ground level impacts provides a sufficient basis for inclusion of this facility in the modeling analysis. This utility operates two cyclone boilers (Dallman Units #31, #32; each nominally rated at 882 mmBtu/hour), a tangentially-fired boiler (Dallman Unit #33; nominally rated at 2,120 mmBtu/hour), and a pulverized coal-fired boiler (Dallman Unit #4; maximum rated capacity 2,440 mmBtu/hour). All of these boilers have the capability to fire natural gas as a startup fuel. SO_2 emissions are controlled through flue gas desulfurization. The utility can also operate three distillate oil-fired engines that power electrical generators. These engine-generators generally function as a source of backup power to meet various on-site needs for electricity in the event of disruptions in the facility's internal power system. Hourly-specific SO_2 emission rates for calendar years 2012-2015 were provided by CWLP staff for the coal-fired boilers, and additionally, the company estimated SO_2 emission rates for the engines during those periods in which they were in operation during this same timeframe.

Located approximately 29 kilometers northwest of the Kincaid power plant is the CPP facility. It provides steam to the Capitol complex for heating and air conditioning. The power plant is comprised of three coal-fired traveling grate stoker boilers (each rated at 68.3 mmBtu/hour) and two gas-fired boilers (each rated at 140 mmBtu/hour) with distillate fuel oil backup. The gas-fired boilers are used primarily as a backup for the coal-fired boilers. CPP staff provided daily boiler consumption rates of coal and natural gas and developed daily SO_2 emission rates from these fuel usage rates for each day for calendar years 2013-2015. The daily emission rates will be adjusted by Illinois EPA staff to hourly rates assuming continuous operation unless more precise temporal allocation data are available.

Table 4
Facility Actual Emissions – Kincaid Study Area

Company I.D.	Facility Name	SO_2 Emissions (tons per year)		
		2013	**2014**	**2015**
021814AAB	Kincaid Generation, LLC	10,259.1	2,818.2	2,366.3
167120AAO	CWLP	1,174.5	1,203.7	820.9
167120ADP	CPP	298.5	300.8	229.2
Total Emissions	**All Facilities**	**11,732.1**	**4,322.7**	**3,416.4**

Please refer to Appendix A for a proposed emissions inventory and stack parameters for the DRR facility. The proposed inventory should be considered preliminary as it is expected to undergo further refinement (and inclusion of the identified background sources) as the data verification process progresses over the coming months.

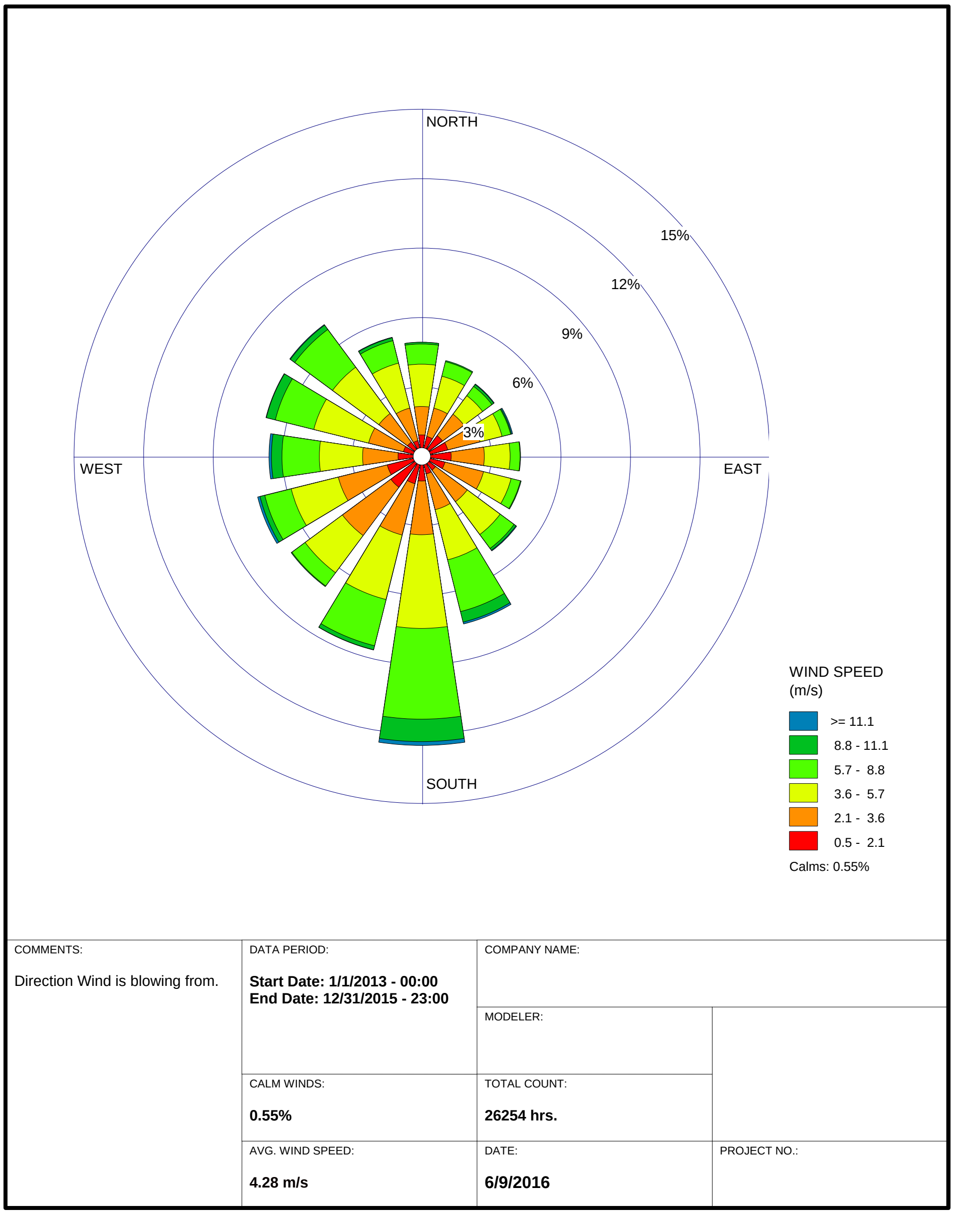
3.2.1.4 Meteorology

The meteorological data site selection and processing discussed in Section 3.1.3 was applied to the Kincaid Study Area. The SO_2 TAD recommends using the three most recent years of meteorology for modeling applicable to the SO_2 air quality characterization process. In this case, data for meteorological years 2013-2015 were available. This time period aligns with the three years of hourly emissions data that will be input to the model. This temporal linking of emissions and meteorology in the model provides the best approximation of the real-world impacts that would occur during that time, should a monitor have been present.

The selection of a representative meteorological station for each of the study areas was based on proximity, similarity of terrain/surface roughness, and climatological consistency. For the Kincaid Study Area, the National Climatic Data Center ("NCDC") NWS surface meteorology from Springfield, Illinois (WBAN No. 93822, 20 miles to the northwest), and coincident upper air observations from Lincoln, Illinois (WBAN No. 04833, 40 miles to the north-northeast), are proposed as best representative of meteorological conditions within the study area.

The three-year surface wind rose for Abraham Lincoln Capital Airport in Springfield, Illinois, is depicted in Figure 6. The frequency and magnitude of wind speed and direction are defined in terms of where the wind is blowing from, parsed out in sixteen 22.5-degree wind sectors. The predominant wind direction during the three-year time period proposed in the modeling is from the south, occurring approximately 12.5% of the time. The highest percentage wind speed range, occurring 31.3% of the time period, was in the 3.6 - 5.7 m/s range.

Figure 6
Abraham Lincoln Capital Airport
Cumulative Annual Wind Rose
2013-2015



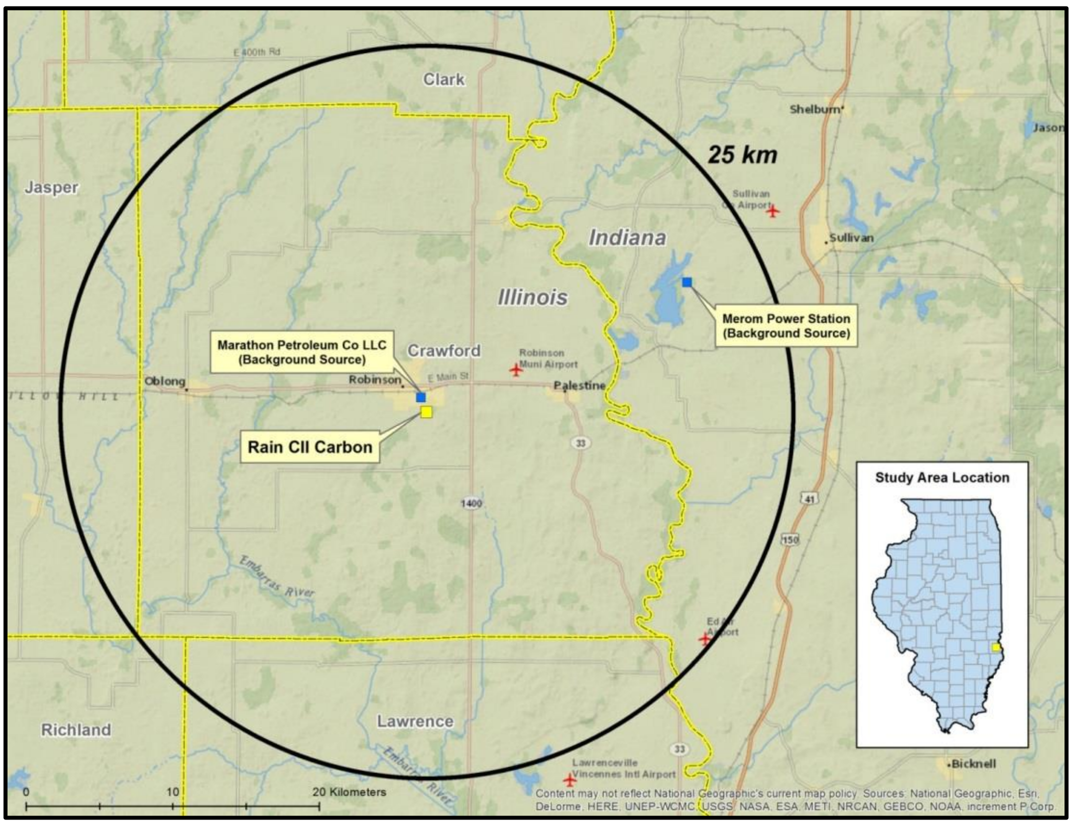
3.2.1.5 Background SO_2

The monitored background integration process discussed in Section 3.1.4.2 will be applied to the Kincaid Study Area modeling analysis. Illinois EPA expects to incorporate temporally-varying background one-hour concentrations developed from the Nilwood monitor, which was selected for the Kincaid Study Area. The Nilwood monitor is located approximately 22 miles southwest of the study area in northern Macoupin County. The monitor, which is operated and maintained by Illinois EPA, has validated hourly SO_2 concentrations for the three years proposed to be utilized in this analysis (2013-2015). The values developed for input are based on the 99th percentile monitored concentrations and vary by hour and season. A table of the proposed background SO_2 seasonally and hourly varying values to be utilized in the Kincaid Study Area modeling is provided in Appendix B.

3.2.2 Rain CII Carbon LLC

Rain CII Carbon, LLC owns and operates a petroleum coke calcining facility one mile southeast of Robinson, Illinois, and approximately seven miles west of the Illinois-Indiana state line in eastern Crawford County. As shown in Figure 7, the plant is located on the southeast edge of town and is bounded to the north by the Marathon Petroleum Co, LLC oil refinery ("Marathon"). The facility has two calcining lines, each processing green petroleum coke through separate countercurrent, inclined rotary kilns (each rated at 50 mmBtu/hour), and rotary coolers. The permitted green coke feed capacity of each kiln is 28 tons per hour. The calcined coke flows by gravity from the kiln into the cooler where it is quenched by a water spray to lower the coke temperature. Each calcining line has an associated pyroscrubber and baghouse. Separate exhaust stacks service the kilns and the coolers. The rotary kilns are considered to be the only significant sources of SO_2 emissions at this facility.

Figure 7
Rain CII Carbon Study Area



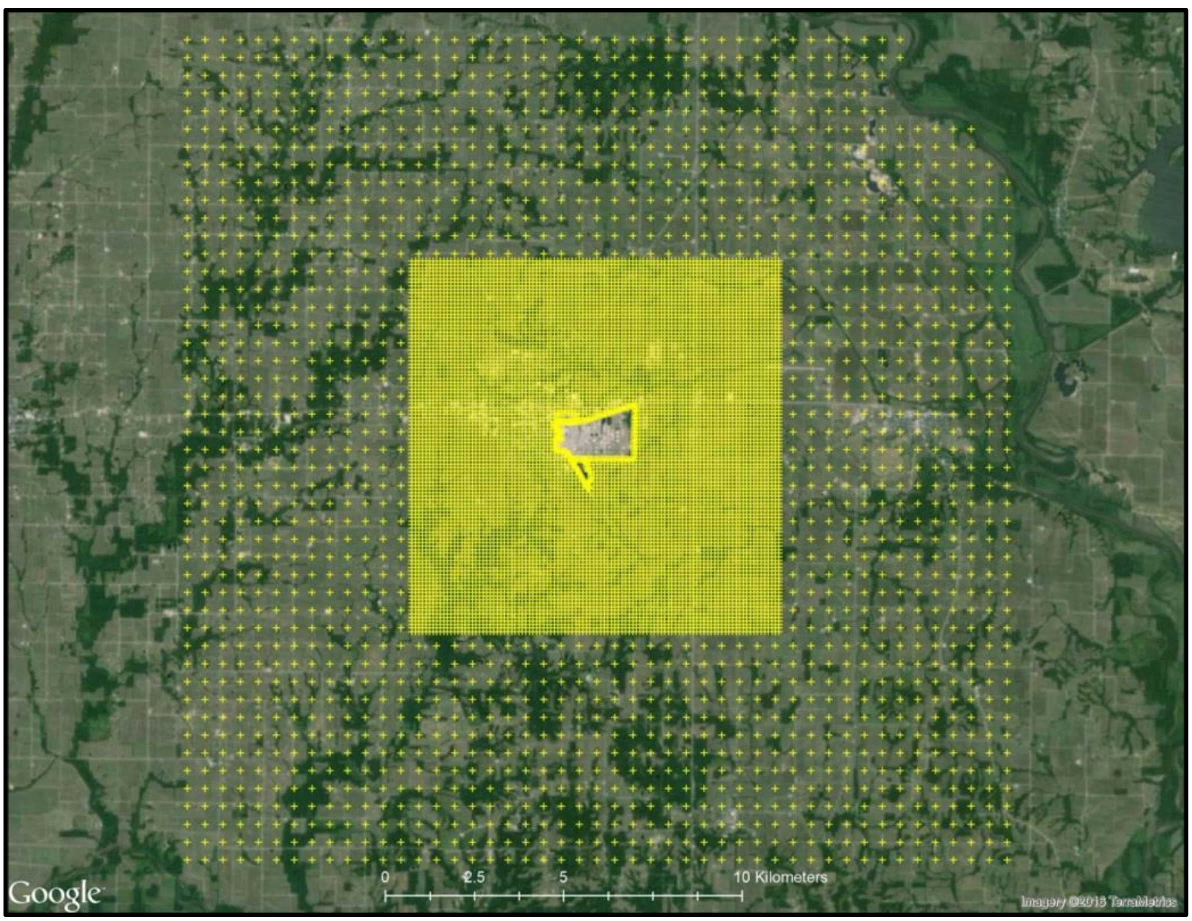
3.2.2.1 Proposed Modeling Domain and Receptor Network

The modeling domain circumscribes an area of a 25-kilometer radius centered on Rain CII Carbon's southernmost kiln stack and includes any potentially significant regional emission sources. This domain includes two background facilities that will be discretely modeled – Marathon, and Hoosier Energy – Merom ("Merom") electric power generating station across the border in Indiana. To ensure adequate capture of predicted maximums near the DRR facility, the receptor network includes fenceline receptors for both the Rain CII Carbon and Marathon facilities and dense near-field receptor arrays. The proposed receptor network for the study area is as follows:

- 50 meters along the fenceline (Rain CII Carbon and Marathon)
- 100 meter grid from the Rain CII Carbon/Marathon fencelines out to a distance of approximately four kilometers
- 500 meter grid from four kilometers out to a distance of approximately 10 kilometers from Rain CII Carbon.

The Rain CII Carbon Study Area receptor network (see Figure 8) consists of 12,615 receptors, and is contained entirely in Crawford County. The study area terrain is best characterized as flat to gently rolling.

Figure 8
Receptor Grid – Rain CII Carbon Study Area



3.2.2.2 Auer's Analysis (Urban/Rural Environment)

The 25-kilometer radius study area and three kilometer near-field ring, centered on the southernmost kiln stack at Rain CII Carbon, were evaluated for determining whether this area represents an urban or rural dispersion regime. The results of the Auer's analysis are presented in Figures 9 and 10 and Table 5.

Figure 9
Land Cover in the Rain CII Carbon Study Area (Urban vs. Rural)

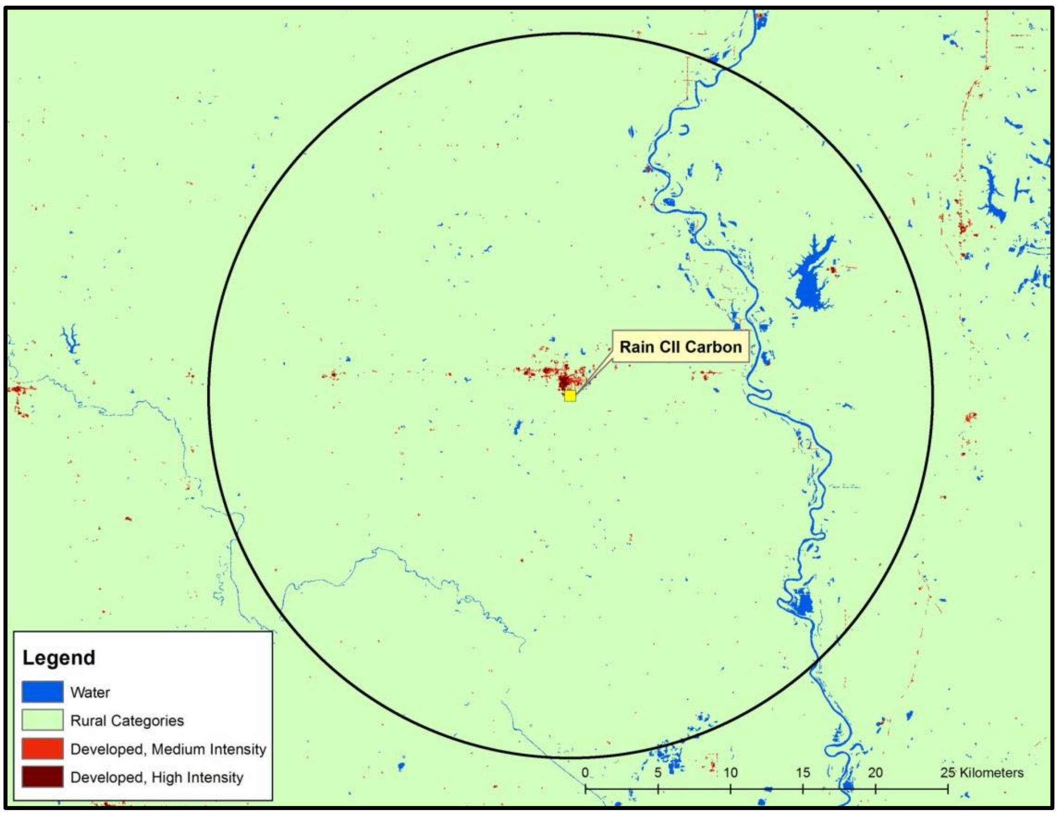


Figure 10
Land Cover within a Three-Kilometer Radius of Rain CII Carbon (Urban vs. Rural)

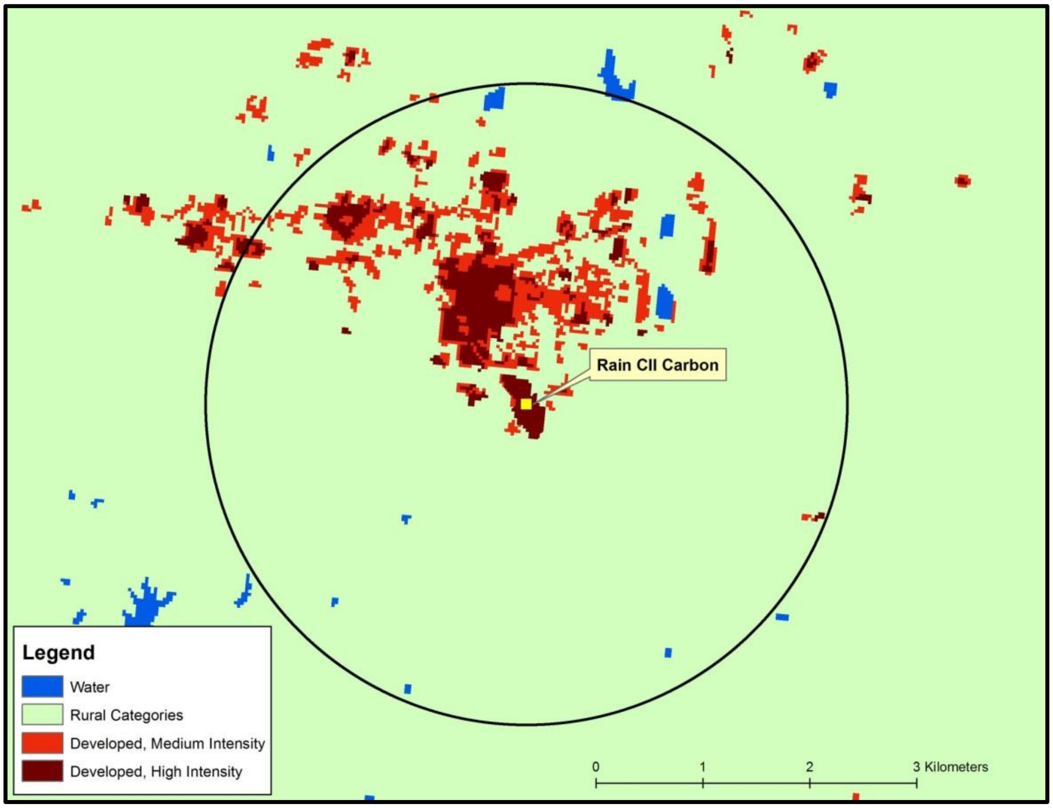


Table 5

Land Cover Percentages by Auer's Category for a Three-Kilometer Radius Area and for the Modeling Domain (25-Kilometer Radius) – Rain CII Carbon Study Area

Rain CII Carbon Study Area Auer's Analysis				Auer's 3 km Ring			Study Area 25 km Ring		
NLCD Value	**NLCD 2011 Description**	**Auer's Code**	**Auer's Class**	**Cell Count**	**Percentage**	**Totals**	**Cell Count**	**Percentage**	**Totals**
23	Developed, Medium Intensity	R2/R3	**Urban**	1,844	5.75%	**9.30%**	4,788	0.22%	**0.29%**
24	Developed, High Intensity	I1/I2/C1		1,135	3.54%		1,620	0.07%	
11	Open Water	A5	**Rural**	141	0.44%	**90.70%**	34,091	1.53%	**99.71%**
21	Developed, Open Space	A1/R4		3,552	11.09%		131,273	5.90%	
22	Developed, Low Intensity	R1		4,753	14.83%		22,657	1.02%	
31	Barren Land (Rock/Sand/Clay)	A3		0	0.00%		601	0.03%	
41	Deciduous Forest	A4		4,206	13.13%		388,606	17.46%	
42	Evergreen Forest	A4		0	0.00%		240	0.01%	
43	Mixed Forest	A4		0	0.00%		0	0.00%	
52	Shrub/Scrub	A4		0	0.00%		75	0.00%	
71	Grassland/Herbaceous	A3		457	1.43%		11,709	0.53%	
81	Pasture/Hay	A3		1,023	3.19%		93,478	4.20%	
82	Cultivated Crops	A2		14,818	46.24%		1,490,126	66.97%	
90	Wood Wetlands	A4		114	0.36%		43,642	1.96%	
95	Emergent Herbaceous Wetlands	A3		0	0.00%		2,286	0.10%	
Analysis based on 30 meter by 30 meter raster cells extracted for each area.			***Total***	***32,043***	***100.00%***	***100.00%***	***2,225,192***	***100.00%***	***100.00%***

The Auer's analysis indicates that the study area is at least 99% rural and the three-kilometer near-field is approximately 90% rural. Based upon these results, the dispersion regime will be treated as rural.

The 2011 NLCD land cover dataset erroneously classified the Rain CII Carbon facility as "Open Water." Due to the relatively small size of this facility, this classification error did not significantly alter the results of the three-kilometer Auer's Analysis. However, the problem was still addressed by using a small 400-meter buffer to extract out all of the misclassified "Open Water" cells that fell within the property boundary of the Rain CII Carbon facility. From this small grid extraction it was determined that 132 cells were misclassified. The Auer's Analysis results were then adjusted by subtracting the 132 cells from the "Open Water" category and adding them to the "Developed, High Intensity" category. This increased the urban land cover percentage from 8.88% to 9.30% for the three-kilometer Auer's Analysis and from 0.28% to 0.29% for the 25-kilometer Auer's Analysis. Therefore, this very small adjustment did not change the final determination that the Rain CII Carbon Study Area should be modeled as Rural.

3.2.2.3 Emissions

Illinois EPA has received emissions data for the three facilities in the Rain CII Carbon Study Area and will work to develop an hourly emissions characterization profile based on the most recent three years of actual emissions. The facilities to be modeled in the study area and their reported actual SO_2 tonnages for 2013-2015 are presented in Table 6. Hourly-specific SO_2 emission rates for the Rain CII Carbon rotary kilns have been provided by the company for calendar years 2012-2015.

Directly north and adjacent to the Rain CII Carbon facility is the Marathon Petroleum Company, LLC refinery. This "nearby" background source has numerous process sources – heaters, boilers, flares, etc. – that emit SO_2 from the combustion of refinery fuel gas. Hourly-specific or hourly-estimated emission rates have been developed for each SO_2-emitting source. Though the magnitude of the reported facility emissions (approximately 202 tons) for 2014 are much lower than those of Rain CII Carbon, the proximity of the refinery to the Rain CII Carbon facility warrants its inclusion in the modeling analysis.

Within 25 kilometers of Rain CII Carbon is the Hoosier Energy – Merom Generating Station in Sullivan County, Indiana. This power plant had reported SO_2 emissions of 3,316 tons in calendar year 2014 and is being included as an additional background source to be discretely modeled. IDEM has provided hourly-specific emission rates, exhaust temperatures, and exit velocities for the two boilers at Merom, as well as stack height, stack diameter, and direction-specific downwash inputs in support of the modeling analysis. The Illinois EPA had requested hourly-specific information on this facility from USEPA, and the information received will potentially be used to refine the IDEM-supplied data.

Please refer to Appendix A for a proposed emissions inventory and stack parameters for the DRR facility. The proposed inventory should be considered preliminary as it is expected to undergo further refinement (and inclusion of the identified background sources) as the data verification process progresses over the coming months.

Table 6
Facility Actual Emissions – Rain CII Carbon Study Area

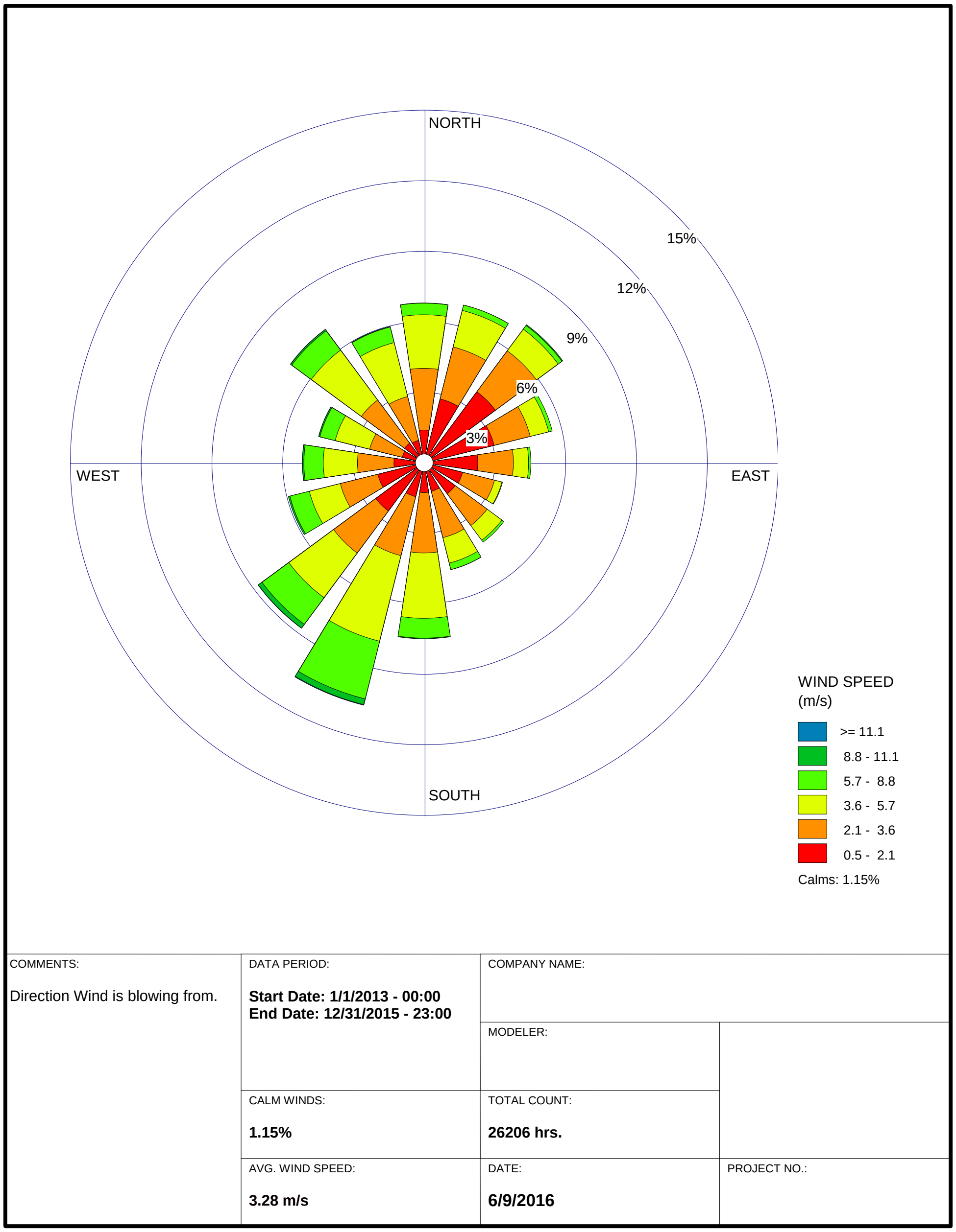
Company I.D.	Facility Name	SO_2 Emissions (tons per year)		
		2013	**2014**	**2015**
033025AAJ	Rain CII Carbon	5,239.7	5,426.8	2,226.0
033808AAB	Marathon Petroleum	181.1	202.0	239.9
1815300005	Merom Generating Station	2,816.2	3,315.9	2,579.4
Total Emissions	**All Facilities**	**8,237.0**	**8,944.7**	**5,045.3**

3.2.2.4 Meteorology

As discussed in Section 3.1.3, the meteorological data site selection and processing procedure will be applied to the Rain CII Carbon Study Area. For the Rain CII Study Area, NCDC NWS surface meteorology from Evansville, Indiana (WBAN No. 93817, 65 miles to the south-southeast), and coincident upper air observations from Lincoln, Illinois (WBAN No. 04833, 115 miles to the north-northwest), are proposed as best representative of meteorological conditions within the study area.

The three-year surface wind rose for Evansville Regional Airport in Evansville, Indiana, is depicted in Figure 11. The frequency and magnitude of wind speed and direction are defined in terms of where the wind is blowing from, parsed out in sixteen 22.5-degree wind sectors. The predominant wind direction during the three-year time period proposed in the modeling is from the south-southwest, occurring approximately 10.6% of the time. The highest percentage wind speed range, occurring 31.3% of the time, was in the 2.1 - 3.6 m/s range.

Figure 11
Evansville Regional Airport, Indiana
Cumulative Annual Wind Rose
2013-2015



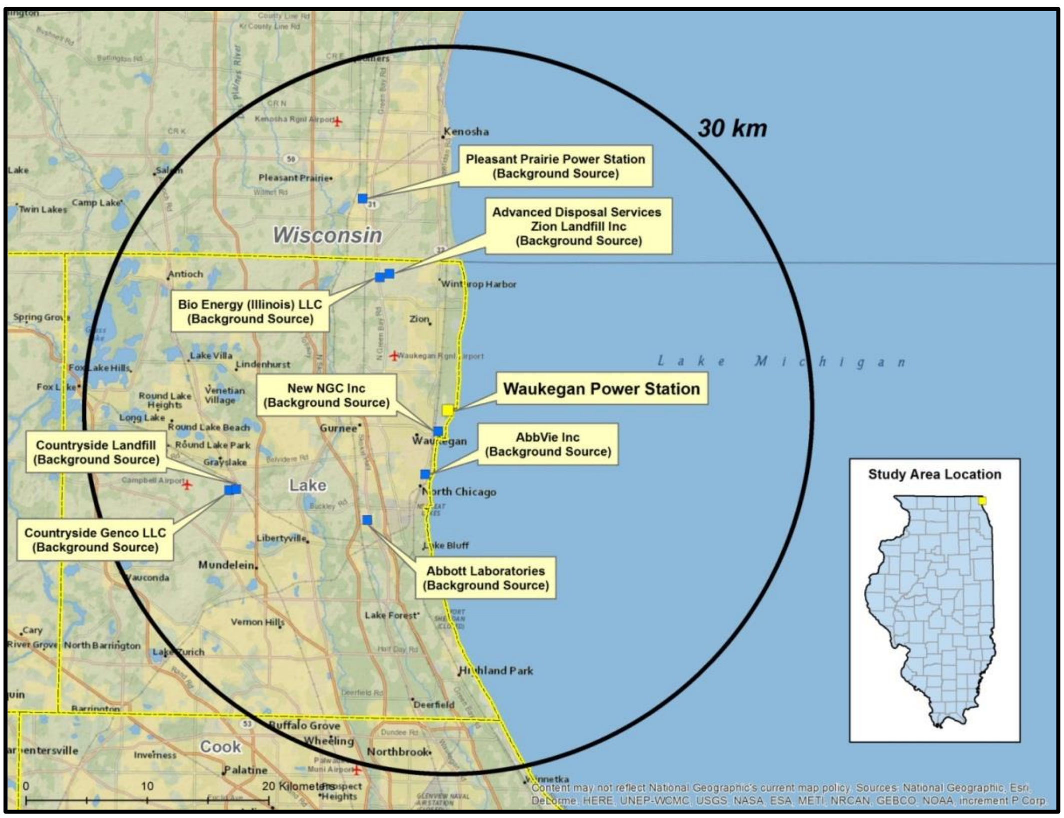
3.2.2.5 Background SO_2

The process of incorporating monitored background data as discussed in Section 3.1.4.2 will be applied to the Rain CII Carbon Study Area modeling analysis. Illinois EPA expects to incorporate temporally-varying background one-hour concentrations developed from the Nilwood monitor, which was selected for the Rain CII Carbon Study Area. The Nilwood monitor is located approximately 115 miles west-northwest of the study area in northern Macoupin County. The monitor, which is operated and maintained by Illinois EPA, has validated hourly SO_2 concentrations for the three years proposed to be utilized in this analysis (2013-2015). The values developed for input are based on the 99th percentile monitored concentrations and vary by hour and season. A table of the proposed background SO_2 seasonally and hourly varying values to be utilized in the Rain CII Carbon Study Area modeling is provided in Appendix B.

3.2.3 Midwest Generation LLC – Waukegan

NRG Energy Inc. ("NRG") owns the Midwest Generation LLC – Waukegan (Waukegan Station) electrical power generating station located in Lake County, along a section of western Lake Michigan coastal area in the City of Waukegan (see Figure 12). The company operates two coal-fired boilers (Unit #7 and Unit #8) with nominal capacities of 3,255 and 3,262 mmBtu/hour, and these boilers also have the capability of firing natural gas and/or fuel oil either with or without coal. SO_2 emissions are controlled through dry sorbent injection of trona and the associated use of electrostatic precipitators. The company operates four distillate oil-fired turbines, each with a nominal capacity of 552.6 mmBtu/hour, to meet peak power demands. A natural gas-fired auxiliary boiler, with a nominal capacity of 51.1 mmBtu/hour, is used to provide steam for building heat and other internal purposes, but not for electricity generation by the steam turbine generators.

Figure 12
Midwest Generation LLC - Waukegan Study Area



3.2.3.1 Proposed Modeling Domain and Receptor Network

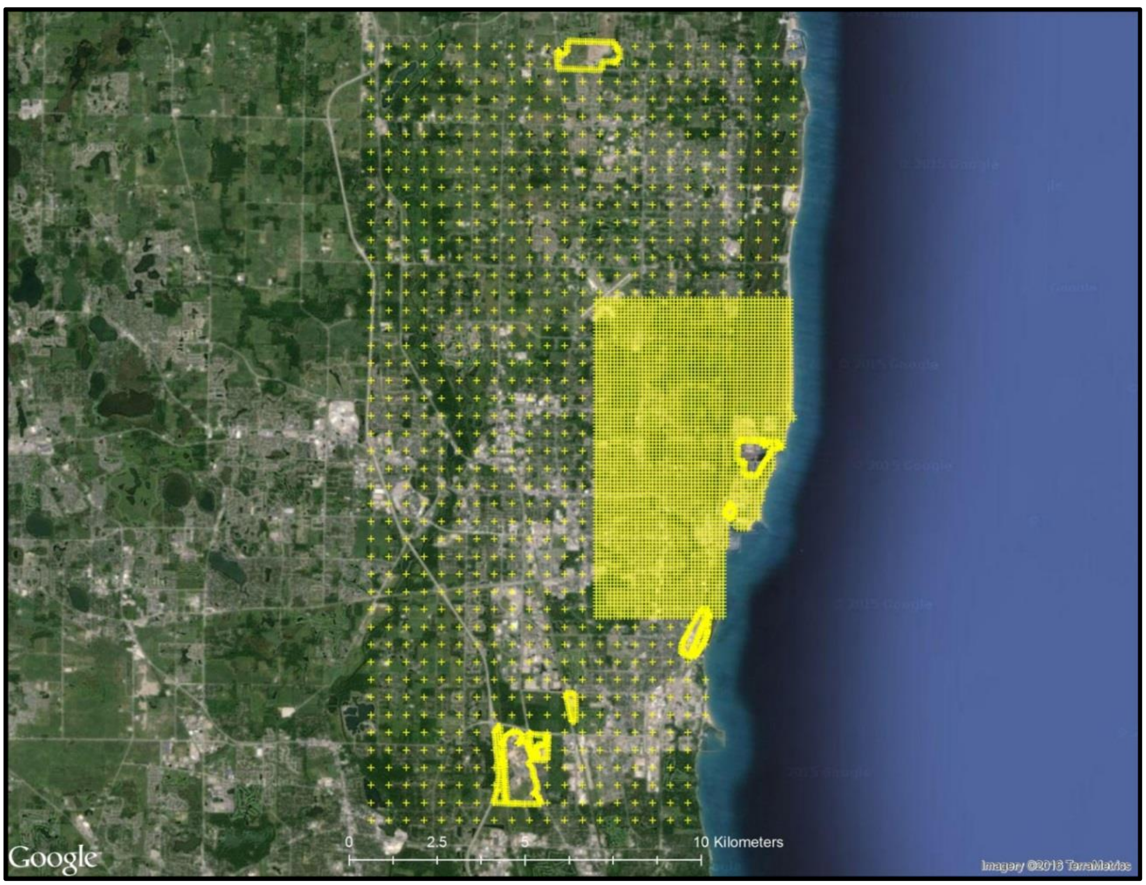
The proposed modeling domain for the Waukegan Station and potentially significant regional emission sources is centered on the generating station's southernmost primary boiler stack and extends outward to encompass an area of 30-kilometer radius. This domain includes Waukegan

Station and eight background sources (Abbvie Inc.; New NGC Inc.; Advanced Disposal Services Zion Landfill Inc.; Bio Energy (Illinois) LLC; Abbott Laboratories; Countryside Genco, LLC; Countryside Landfill; and Wisconsin's Pleasant Prairie Generating Station. To ensure adequate capture of predicted maximums near the DRR facility, the receptor network includes fenceline receptors and a dense near-field receptor array. The proposed receptor network for the study area spacing is as follows:

- 50 meters along fencelines (Waukegan Station, New NGC, Abbvie, Abbott Laboratories, Advanced Disposal Services Zion Landfill, and Bio Energy (Illinois))
- 100 meters from the Waukegan Station out to a distance of approximately four kilometers
- 500 meters from four kilometers out to a distance of approximately 10 kilometers from the Waukegan Station.

The Waukegan Study Area receptor network (see Figure 13) consists of 6,031 receptors, and is contained entirely in Lake County. Per the recommendation of the TAD, receptors were not placed on large water bodies (Lake Michigan). The study area terrain is best characterized as flat to gently rolling.

Figure 13
Receptor Grid – Waukegan Study Area



3.2.3.2 Auer's Analysis (Urban/Rural Environment)

The 30-kilometer study area and three-kilometer near-field ring applied in the Auer's analysis for the Waukegan Study Area are both centered on the southernmost primary boiler stack at Waukegan Station. The results of the Auer's analysis for the Waukegan Study Area are presented in Figure 14, Figure 15 and Table 7.

Figure 14
Land Cover in the Waukegan Study Area
(Urban vs. Rural)

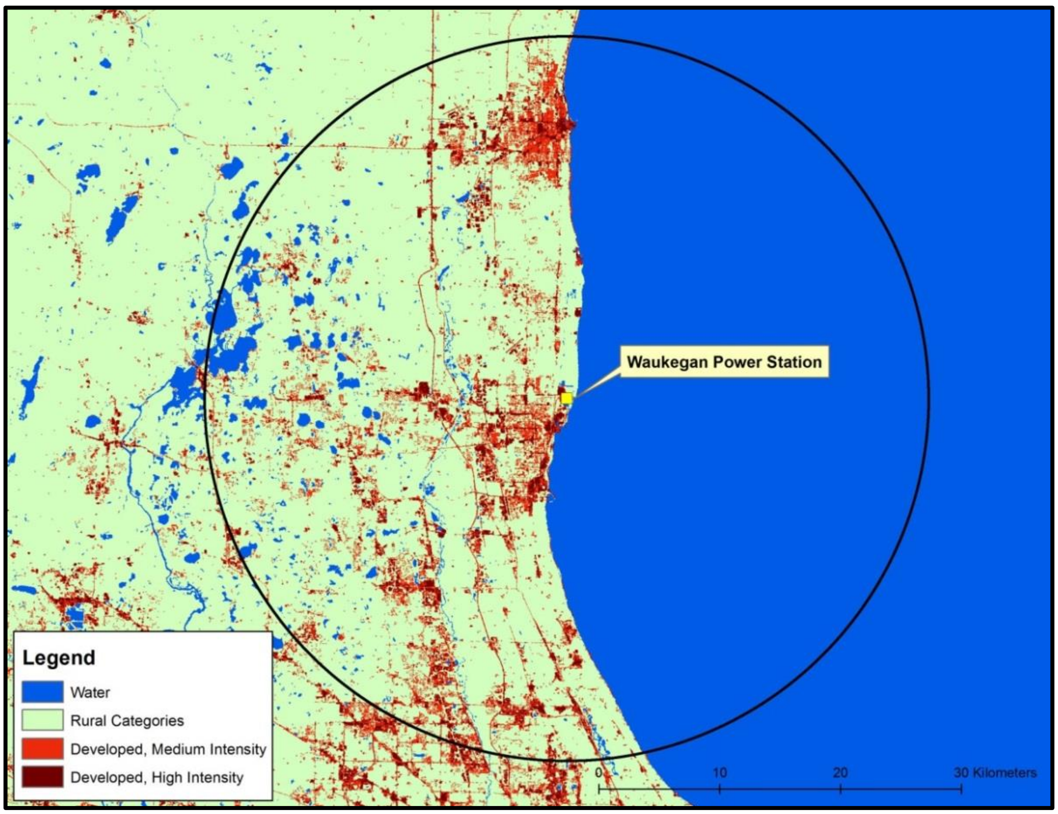


Figure 15
Land Cover within a Three-Kilometer Radius of Waukegan Station (Urban vs. Rural)

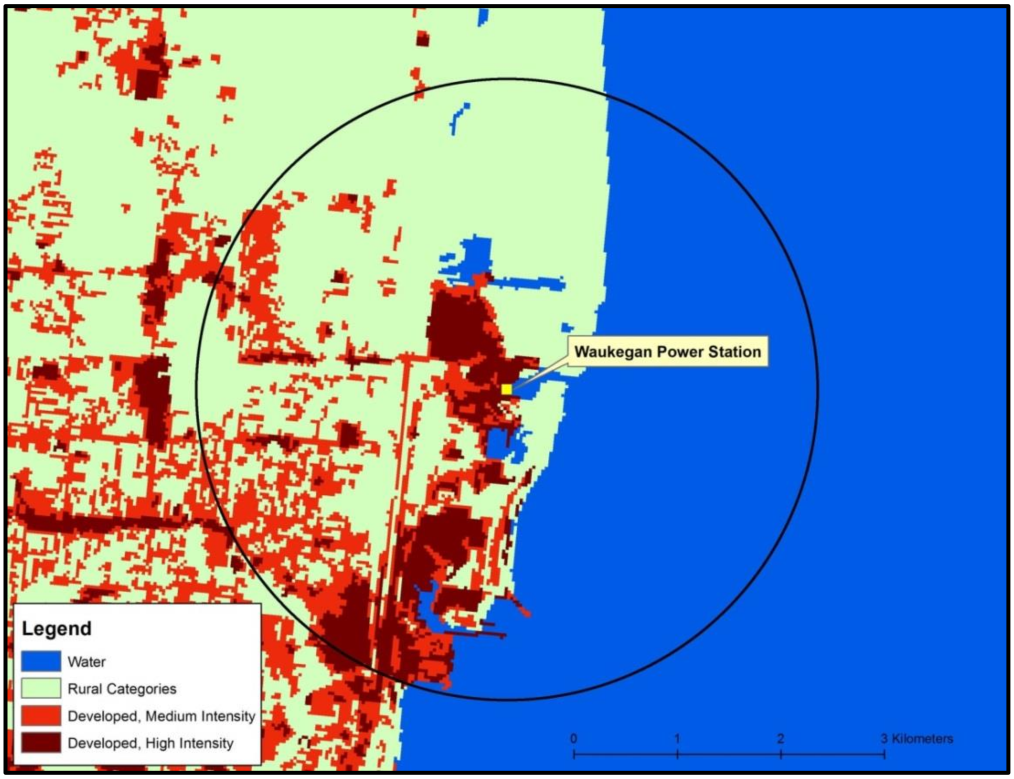


Table 7

Land Cover Percentages by Auer's Category for a Three-Kilometer Radius Area and for the Modeling Domain (30-Kilometer Radius) – Waukegan Study Area

Waukegan Study Area Auer's Analysis				Auer's 3 km Ring			Study Area 30 km Ring		
NLCD Value	NLCD 2011 Description	Auer's Code	Auer's Class	Cell Count	Percentage	Totals	Cell Count	Percentage	Totals
23	Developed, Medium Intensity	R2/R3	Urban	3,755	11.79%	19.39%	175,101	5.50%	7.61%
24	Developed, High Intensity	I1/I2/C1		2,421	7.60%		67,206	2.11%	
11	Open Water	A5		13,342	41.89%		1,612,299	50.64%	
21	Developed, Open Space	A1/R4		2,246	7.05%		256,320	8.05%	
22	Developed, Low Intensity	R1		3,692	11.59%		391,686	12.30%	
31	Barren Land (Rock/Sand/Clay)	A3		893	2.80%		6,584	0.21%	
41	Deciduous Forest	A4		1,069	3.36%		161,115	5.06%	
42	Evergreen Forest	A4		44	0.14%		859	0.03%	
43	Mixed Forest	A4	Rural	91	0.29%	80.61%	19,318	0.61%	92.39%
52	Shrub/Scrub	A4		7	0.02%		5,202	0.16%	
71	Grassland/Herbaceous	A3		202	0.63%		49,433	1.55%	
81	Pasture/Hay	A3		0	0.00%		62,997	1.98%	
82	Cultivated Crops	A2		0	0.00%		265,513	8.34%	
90	Wood Wetlands	A4		620	1.95%		72,447	2.28%	
95	Emergent Herbaceous Wetlands	A3		3,467	10.89%		37,720	1.18%	
Analysis based on 30 meter by 30 meter raster cells extracted for each area.			*Total*	*31,849*	*100.00%*	*100.00%*	*3,183,800*	*100.00%*	*100.00%*

The Auer's analysis indicates that the study area is at least 92% rural and the three-kilometer near-field is approximately 81% rural. Based upon these results, the dispersion regime will be treated as rural.

3.2.3.3 Emissions

Illinois EPA is currently in the process of acquiring or developing the best available emissions data for the nine facilities in the Waukegan Study Area and will work to develop an hourly emissions characterization profile based on the most recent three years of actual emissions. For the Waukegan Station, the parent company NRG, has provided hourly-specific SO_2 emission rates for Unit #7 and Unit #8 for calendar years 2012-2015. NRG also provided annual SO_2 emission totals and total hours of operation for each of the turbine peaker units during the years 2012-2015. This operational information will be temporally adjusted by IEPA staff to hourly rates consistent with procedures identified in the modeling guidance TAD.

Reported actual annual SO_2 tonnages for 2013-2015 are presented in Table 8 for the DRR facility and the proposed background source facilities to be modeled in this study area. The magnitude of the emissions of these background sources may individually be several orders (or more) less than those of the Waukegan Station. Despite this, the potential for cumulative impacts that may exceed the one-hour SO_2 NAAQS warrants their inclusion. Hourly-specific SO_2 emission rates and estimated hourly stack gas exit temperatures and velocities will be modeled for the WE Energies – Pleasant Prairie power plant (Pleasant Prairie, Wisconsin) based upon information provided by USEPA staff. The development of emission rates for all other sources to be modeled in the Waukegan study area, and for which data was not specifically provided, will adhere to the recommendations in the modeling TAD.

Table 8
Facility Actual Emissions – Waukegan Study Area

Company I.D.	Facility Name	SO_2 Emissions (tons per year)		
		2013	**2014**	**2015**
097190AAC	Midwest Generation LLC – Waukegan	7,750.2	7,683.4	2,338.5
097190AAP	New NGC Inc.	5.8	6.6	6.4
097025AAR	Countryside Genco LLC	23.5	23.0	41.5
097806AAG	Countryside Landfill	23.9	6.3	14.5
097809AAD	Abbot Laboratories	74.1	23.0	0.3
097125AAA	AbbVie Inc.	60.1	16.9	7.3
097200AAV	ADS Zion Landfill Inc.	48.1	28.2	26.7
097200ABC	Bio Energy (Illinois) LLC	40.9	24.7	22.1
230006260	Pleasant Prairie Generating Station	1,173.8	1,310.14	1,335.4
Total Emissions	**All Facilities**	**9,200.4**	**9,122.2**	**3,792.7**

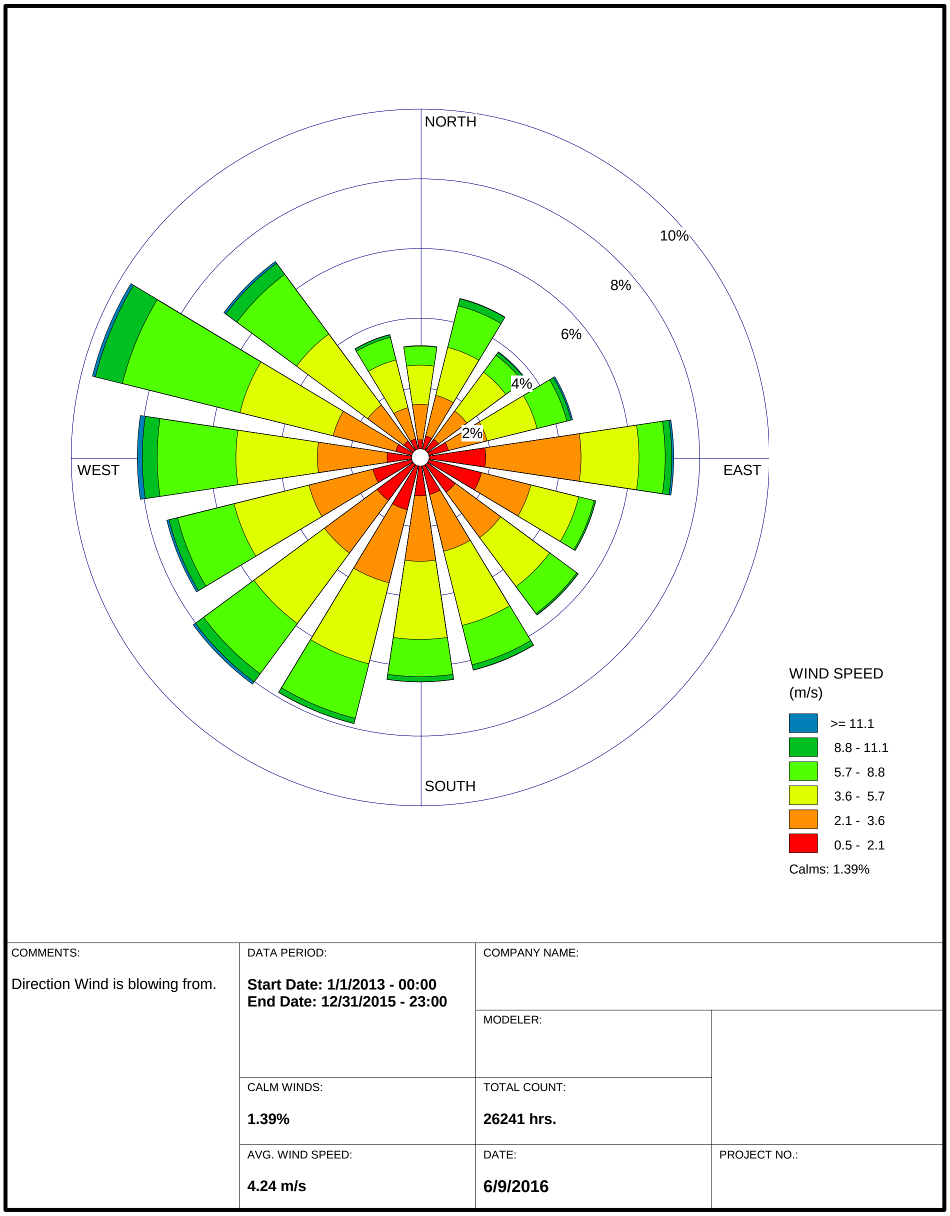
Please refer to Appendix A for a proposed emissions inventory and stack parameters for the DRR facility. The proposed inventory should be considered preliminary as it is expected to undergo further refinement (and inclusion of the identified background sources) as the data verification process progresses over the coming months.

3.2.3.4 Meteorology

The same meteorological data site selection and processing procedure used in the previous study areas will be applied to the Waukegan Study Area. For the Waukegan Study Area, NCDC NWS surface meteorology from Milwaukee, Wisconsin (WBAN No. 94982, 40 miles to the north), and coincident upper air observations from Davenport, Iowa (WBAN No. 14923, 152 miles to the southwest), is proposed as reasonably representative of meteorological conditions within the study area. As an alternative meteorological dataset, Illinois EPA is also investigating the viability of utilizing nearby Waukegan Regional airport surface data due to its proximity to the Waukegan Station. Further investigation into the robustness of the data is planned.

The three-year surface wind rose for General Mitchell International Airport (Milwaukee, WI) is depicted in Figure 16. The frequency and magnitude of wind speed and direction are defined in terms of where the wind is blowing from, parsed out in sixteen 22.5-degree wind sectors. The predominant wind direction during the three-year time period proposed in the modeling is from the west-northwest, occurring approximately 9.6% of the time. The highest percentage wind speed range, occurring 30.7% of the time period, was in the 3.6 - 5.7 m/s range.

Figure 16
General Mitchell International Airport, Milwaukee, Wisconsin
Cumulative Annual Wind Rose
2013-2015



3.2.2.5 Background SO_2

The Northbrook and Oglesby, Illinois, monitors were evaluated for use as background SO_2 monitors for the Waukegan Study Area. Although the Northbrook monitor is much closer to the study area, the data completeness percentage was too low to consider it a viable background site for the modeling. The Oglesby monitor is located approximately 98 miles southwest of the center of the study area in

LaSalle County. This monitor, which is operated and maintained by Illinois EPA, has validated hourly SO_2 concentrations for the three years proposed to be utilized in this analysis (2013-2015).

Illinois EPA expects to incorporate temporally-varying background one-hour concentrations developed from the Oglesby monitor. The values developed for input are based on the 99th percentile monitored concentrations and vary by hour and season in the same manner as discussed previously in Section 3.1.4.2. A table of the proposed background SO_2 seasonally and hourly varying values to be utilized in the Waukegan Study Area modeling is provided in Appendix B.

3.2.4 Dynegy Midwest Generation–Baldwin/Prairie State Generating Station

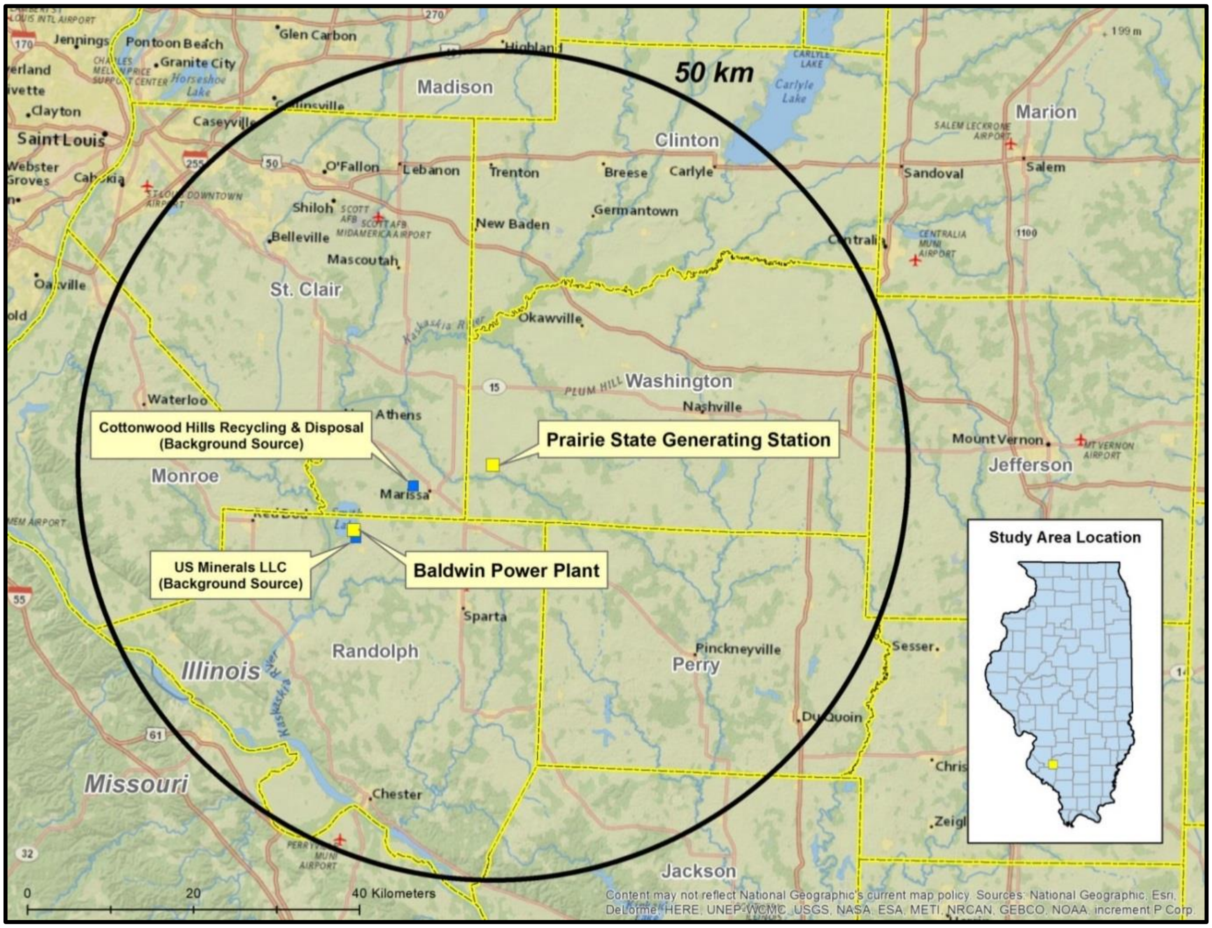
The Dynegy Midwest Generation Inc. – Baldwin Power Plant ("DMG – Baldwin") is located just outside the community of Baldwin, in Randolph County. The Illinois EPA air emissions inventory system indicates that DMG – Baldwin has four SO_2-emitting sources: three steam electric coal-fired generating units that are nominally rated at 584 megawatts (Boiler #1), 586 megawatts (Boiler #2), and 627 megawatts (Boiler #3), and an oil-fired auxiliary heating boiler that is nominally rated at 130 mmBtu/hour. SO_2 emissions from the three steam electric coal-fired generating units are controlled by flue gas desulfurization systems (sorbent injection and scrubbers) and exhaust through separate unobstructed vertical stacks. The uncontrolled auxiliary heating boiler has horizontally-directed exhaust, and modeling options will be selected (in accordance with federal modeling guidance) so that release parameters for this point source are automatically adjusted to minimize mechanically-induced plume rise.

Approximately 25 kilometers to the east of DMG – Baldwin, near the town of Lively Grove in rural Washington County, is the Prairie State Generating Company ("PSGC") power plant. The company operates two pulverized coal boilers, each with a maximum rated capacity of approximately 7,500 mmBtu/hour, an auxiliary natural gas-fired boiler, and two emergency engines burning ultra-low sulfur diesel fuel. SO_2 emissions from the power generation boilers are controlled through wet flue gas desulfurization (scrubbers) in separate air pollution control trains, and released to the atmosphere through separate flues in a common stack.

3.2.4.1 Proposed Modeling Domain and Receptor Network

The modeling domain for capturing regional emission sources is proposed to be centered on the PSGC main stack and extend outward to encompass an area with 50-kilometer radius. As depicted in Figure 17, this domain includes the Baldwin and Prairie State plants and two background sources (U. S. Minerals Inc. and Cottonwood Hills Recycling & Disposal).

Figure 17
Baldwin and Prairie State Generating Station Study Area

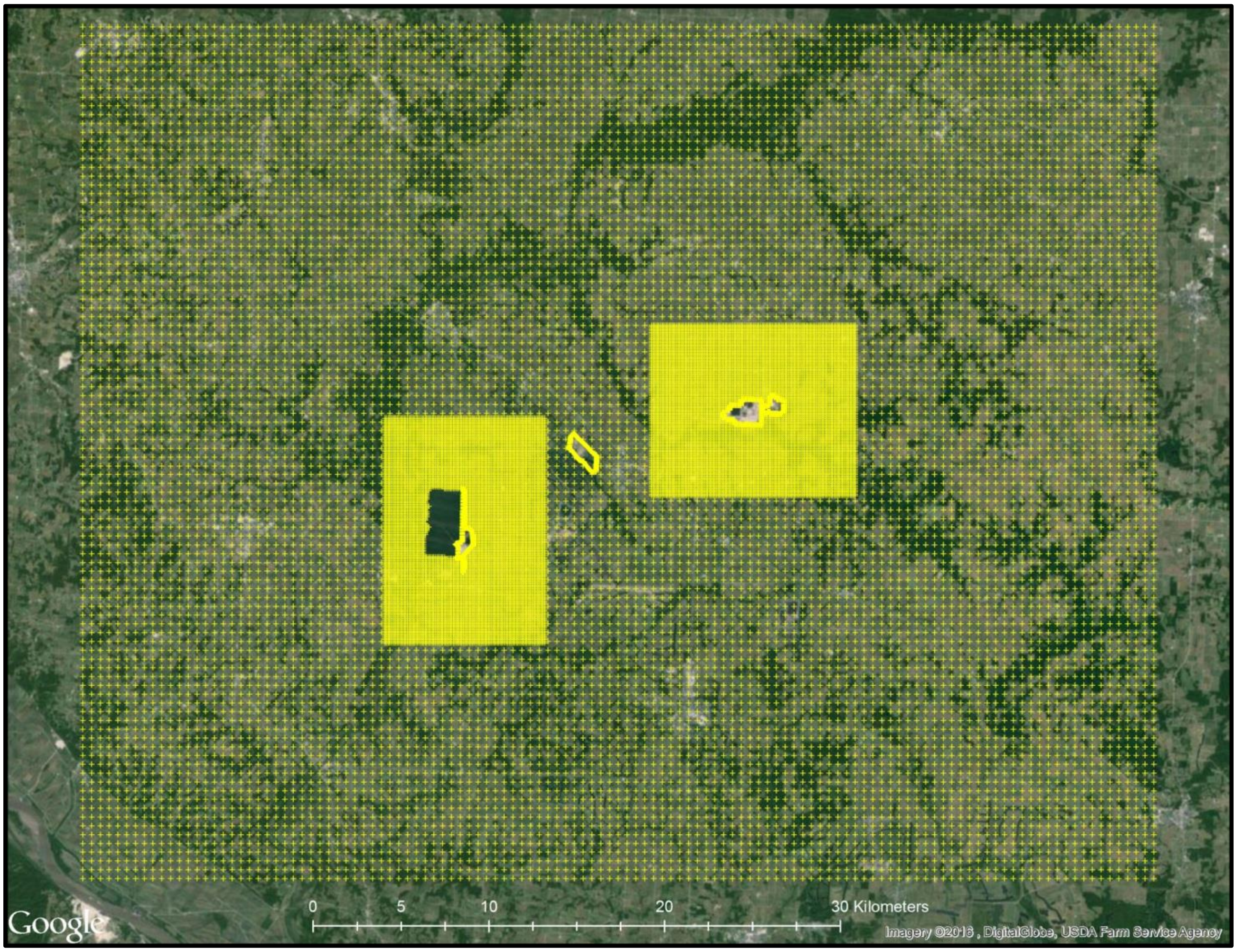


To ensure adequate capture of predicted maximums near the DMG – Baldwin and PSGC facilities, the receptor network includes fenceline receptors and a dense near-field receptor array. The proposed receptor network for the study area is as follows:

- 50 meters along the fencelines (DMG – Baldwin, PSGC, U.S. Minerals, and Cottonwood Hills)
- 100 meters from the DMG – Baldwin and PSGC fencelines out to a distance of approximately four kilometers
- 500 meters from four kilometers out to a distance of approximately 20 kilometers from both main power plants.

The DMG – Baldwin and PSGC receptor network (see Figure 18) consists of 33,907 receptors, and is centered approximately at a midpoint between the two large power plants. The grid encompasses portions of Randolph, Washington, St. Clair, and Perry Counties in Illinois. Per the recommendation of the TAD, receptors were not placed on large water bodies (Lake Baldwin, Mississippi River). The study area terrain is best characterized as flat to gently rolling.

Figure 18
Receptor Grid
Baldwin and Prairie State Generating Station Study Area



3.2.4.2 Auer's Analysis (Urban/Rural Environment)

An Auer's analysis was applied to the Baldwin and Prairie State Generating Station Study Area. Figures 19 and 20 graphically depict the near-field areas (three-kilometer rings) applied in the Auer's analysis to the DMG – Baldwin and PSGC plants, respectively. Table 9 provides a statistical breakdown by land cover category for both three-kilometer rings. The same analysis encompassing the full study area is provided in Figure 21 and Table 10.

Figure 19
Land Cover within a Three-Kilometer Radius of the Baldwin Plant
(Urban vs. Rural)

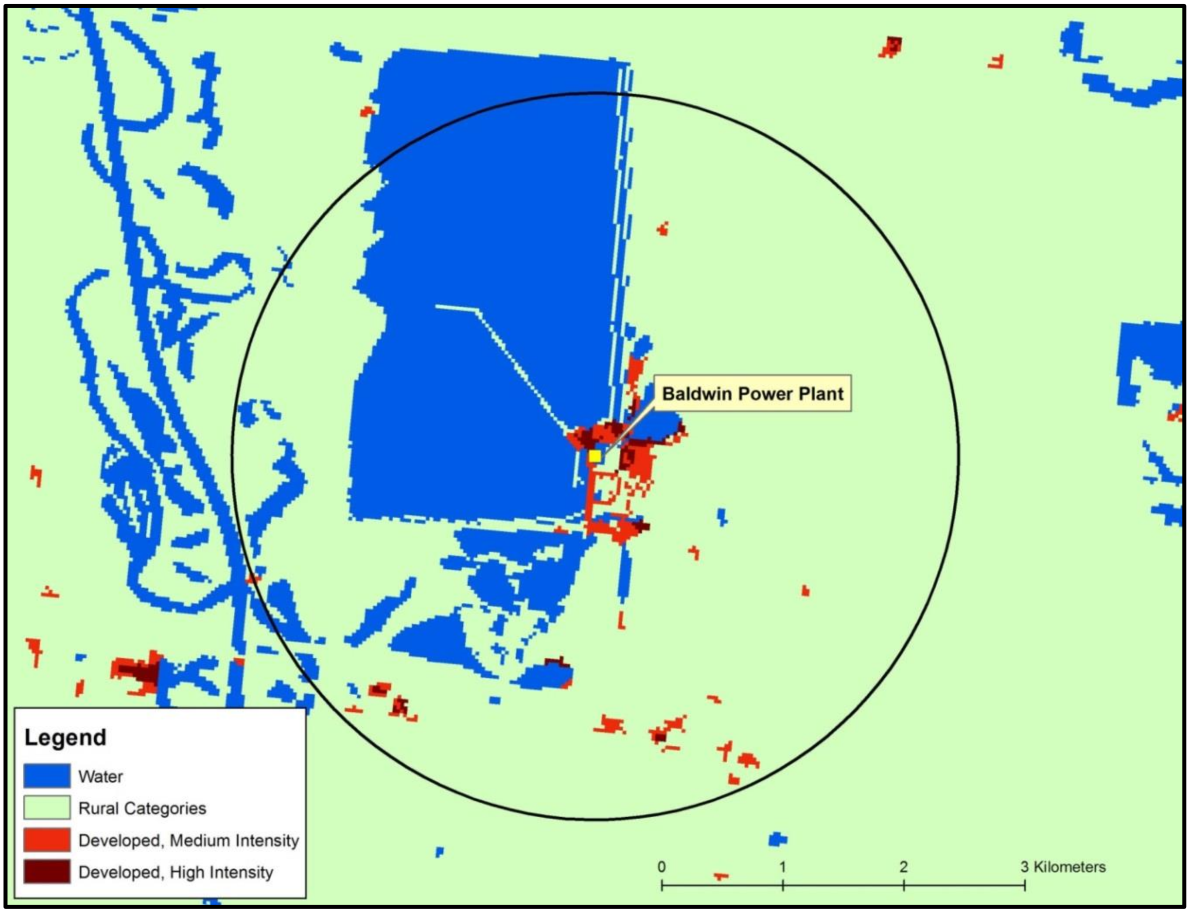


Figure 20
Land Cover within a Three-Kilometer Radius of Prairie State Generating Station (Urban vs. Rural)

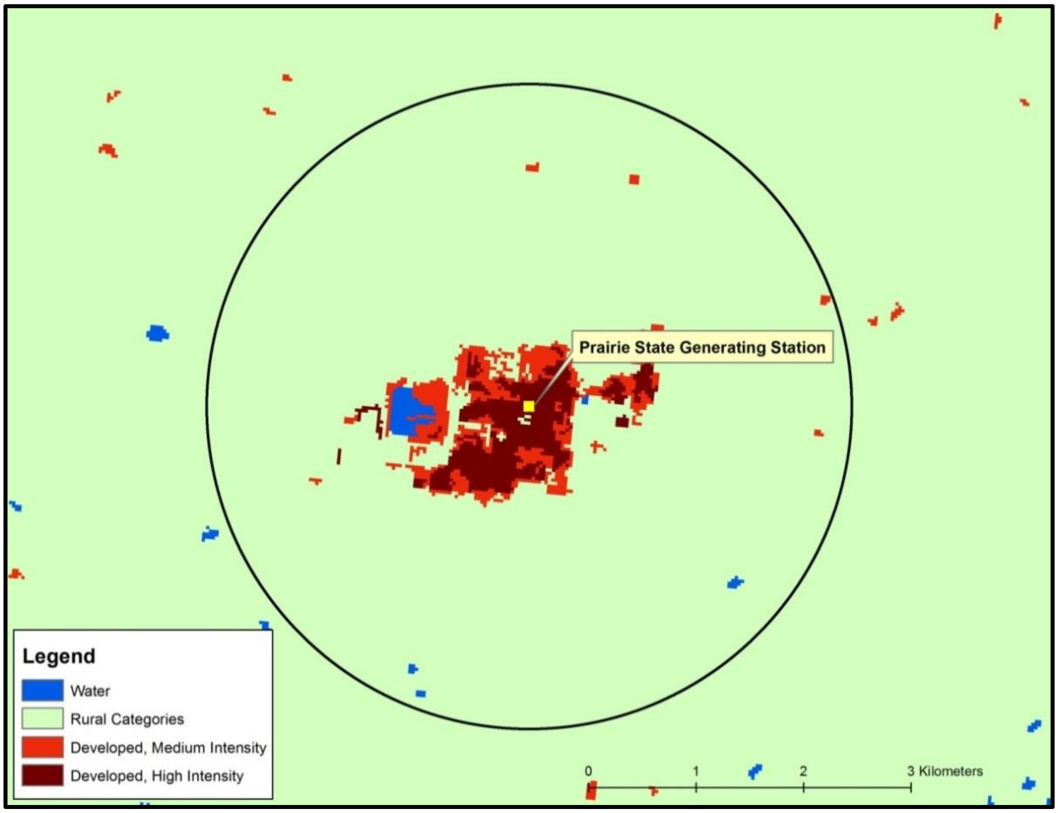


Table 9
Land Cover Percentages by Auer's Category for Three-Kilometer Radius Areas – Baldwin and Prairie State Generating Station

Baldwin-Prairie State Study Area Auer's Analysis				Baldwin Auer's 3 km Ring			PSGC Auer's 3 km Ring		
NLCD Value	NLCD 2011 Description	Auer's Code	Auer's Class	Cell Count	Percentage	Totals	Cell Count	Percentage	Totals
23	Developed, Medium Intensity	R2/R3	Urban	457	1.46%	1.89%	1,057	3.30%	6.75%
24	Developed, High Intensity	I1/I2/C1		136	0.43%		1,104	3.45%	
11	Open Water	A5	Rural	9,298	29.61%	98.11%	167	0.52%	93.25%
21	Developed, Open Space	A1/R4		2,013	6.41%		1,444	4.51%	
22	Developed, Low Intensity	R1		949	3.02%		982	3.07%	
31	Barren Land (Rock/Sand/Clay)	A3		307	0.98%		61	0.19%	
41	Deciduous Forest	A4		3,131	9.97%		3,228	10.08%	
42	Evergreen Forest	A4		0	0.00%		0	0.00%	
43	Mixed Forest	A4		0	0.00%		0	0.00%	
52	Shrub/Scrub	A4		0	0.00%		0	0.00%	
71	Grassland/Herbaceous	A3		1,164	3.71%		112	0.35%	
81	Pasture/Hay	A3		1,745	5.56%		3,635	11.35%	
82	Cultivated Crops	A2		11,861	37.77%		17,865	55.79%	
90	Wood Wetlands	A4		246	0.78%		2,364	7.38%	
95	Emergent Herbaceous Wetlands	A3		94	0.30%		0	0.00%	
Analysis based on 30 meter by 30 meter raster cells extracted for each area.			*Total*	*31,401*	*100.00%*	*100.00%*	*32,019*	*100.00%*	*100.00%*

Figure 21
Land Cover in the Baldwin and Prairie State Generating Station Study Area (Urban vs. Rural)

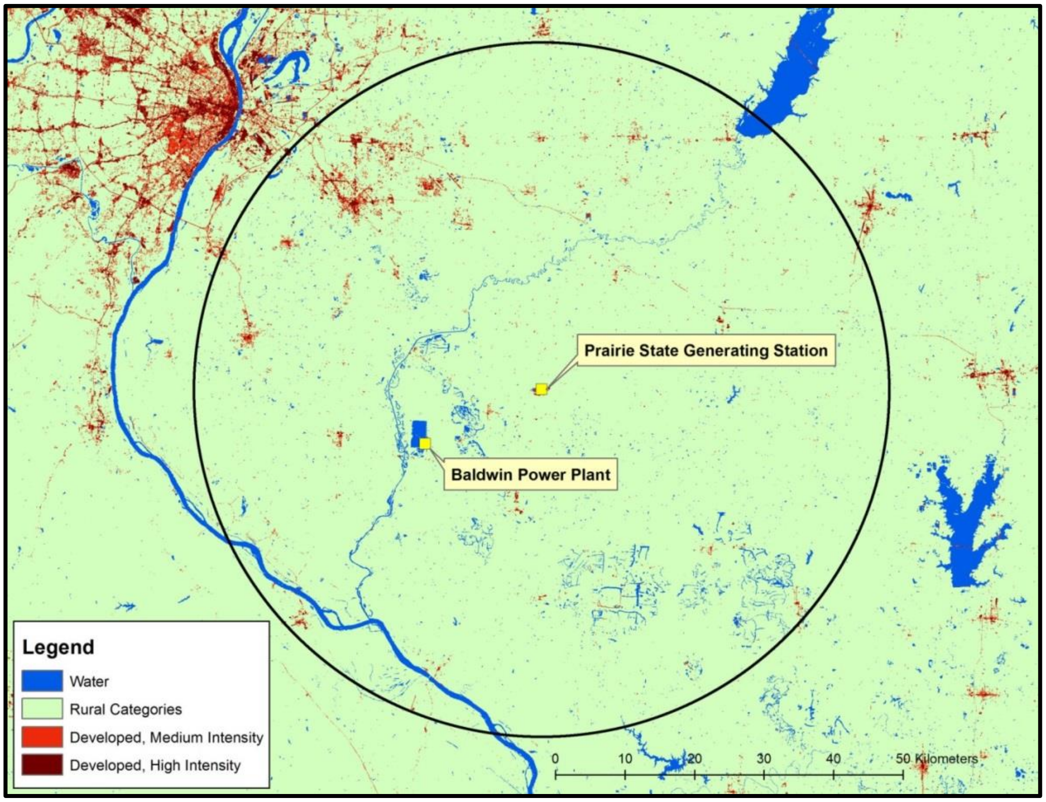


Table 10
Land Cover Percentages by Auer's Category for the Modeling Domain (50-Kilometer Radius) – Baldwin and Prairie State Generating Station Study Area

Baldwin-Prairie State Study Area Auer's Analysis				Study Area 50 km Ring		
NLCD Value	**NLCD 2011 Description**	**Auer's Code**	**Auer's Class**	**Cell Count**	**Percentage**	**Totals**
23	Developed, Medium Intensity	R2/R3	**Urban**	92,258	1.04%	**1.26%**
24	Developed, High Intensity	I1/I2/C1		19,620	0.22%	
11	Open Water	A5	**Rural**	202,691	2.28%	**98.74%**
21	Developed, Open Space	A1/R4		431,525	4.85%	
22	Developed, Low Intensity	R1		365,733	4.11%	
31	Barren Land (Rock/Sand/Clay)	A3		14,458	0.16%	
41	Deciduous Forest	A4		1,695,685	19.07%	
42	Evergreen Forest	A4		1,446	0.02%	
43	Mixed Forest	A4		1,886	0.02%	
52	Shrub/Scrub	A4		341	0.00%	
71	Grassland/Herbaceous	A3		151,951	1.71%	
81	Pasture/Hay	A3		1,819,610	20.46%	
82	Cultivated Crops	A2		3,830,733	43.08%	
90	Wood Wetlands	A4		248,303	2.79%	
95	Emergent Herbaceous Wetlands	A3		15,959	0.18%	
Analysis based on 30 meter by 30 meter raster cells extracted for each area.			***Total***	***8,892,199***	***100.00%***	***100.00%***

The Auer's analysis indicates the study area is at least 98% rural and the three-kilometer near-field areas for both power stations are over 93% rural. Based upon these results, the dispersion regime will be treated as rural.

3.2.4.3 Emissions

Illinois EPA has received or is in the process of acquiring the best available emissions data for the four facilities in the Baldwin and Prairie State Generating Station Study Area and will work to develop an hourly emissions characterization profile based on the most recent three years of actual emissions.

Hourly-specific SO_2 emission rates for the DMG – Baldwin coal-fired generating units (Boiler #1, Boiler #2, and Boiler #3) have been provided by Dynegy Inc. for calendar years 2012-2015. For the auxiliary heating boiler, monthly fuel usage (gallons of #2 fuel oil) and operating time (hours per calendar month) were provided for the same period. Calculation of SO_2 emissions from the auxiliary boiler will be based upon standard emission factors and then temporally allocated for modeling by assigning an even hourly distribution for the specific month of operation.

Prairie State Generating Company provided hourly-specific temperature, flow rate, and emissions data for both of the pulverized coal-fired boilers (Unit #1 and Unit #2), and hourly emissions data computed from gas consumption records and AP-42 emission factors for the auxiliary boiler. The data for all boilers were for the period 2012-2015. The company also provided annual hours of operation for both the emergency diesel fire pump and the emergency diesel generator during this four-year period. Emission estimates for these two sources will be calculated based upon emission factors from the company's Annual Emissions Report, and the emissions will be temporally allocated assuming an even distribution for each specific year modeled.

Total actual emissions reported for both the DMG – Baldwin facility and the PSGC facility for years 2013-2015 are provided in Table 11, together with the annual emission totals for the two background sources that will be modeled (U.S. Minerals Inc. and Cottonwood Hills Recycling & Disposal). The quantity of the emissions for these background sources are orders of magnitude less than those of the power plants, but given their proximity to the power plants, they will be included in the modeling simulations to assure adequate consideration and assessment of areas of potential high local impact.

Table 11
Facility Actual Emissions – Baldwin and Prairie State Generating Station Study Area

Company I.D.	Facility Name	SO_2 Emissions (tons per year)		
		2013	**2014**	**2015**
157851AAA	DMG Baldwin	4,803.4	4,406.4	4,162.9
189808AAB	Prairie State Generating Station	4,719.4	5,696.1	7,847.4
157851AAC	U. S. Minerals Inc.	3.1	3.6	1.0
163075AAL	Cottonwood Hills Recycling & Disposal	16.9	21.8	24.3
Total Emissions	**All Facilities**	**9,542.8**	**10,127.9**	**12,035.6**

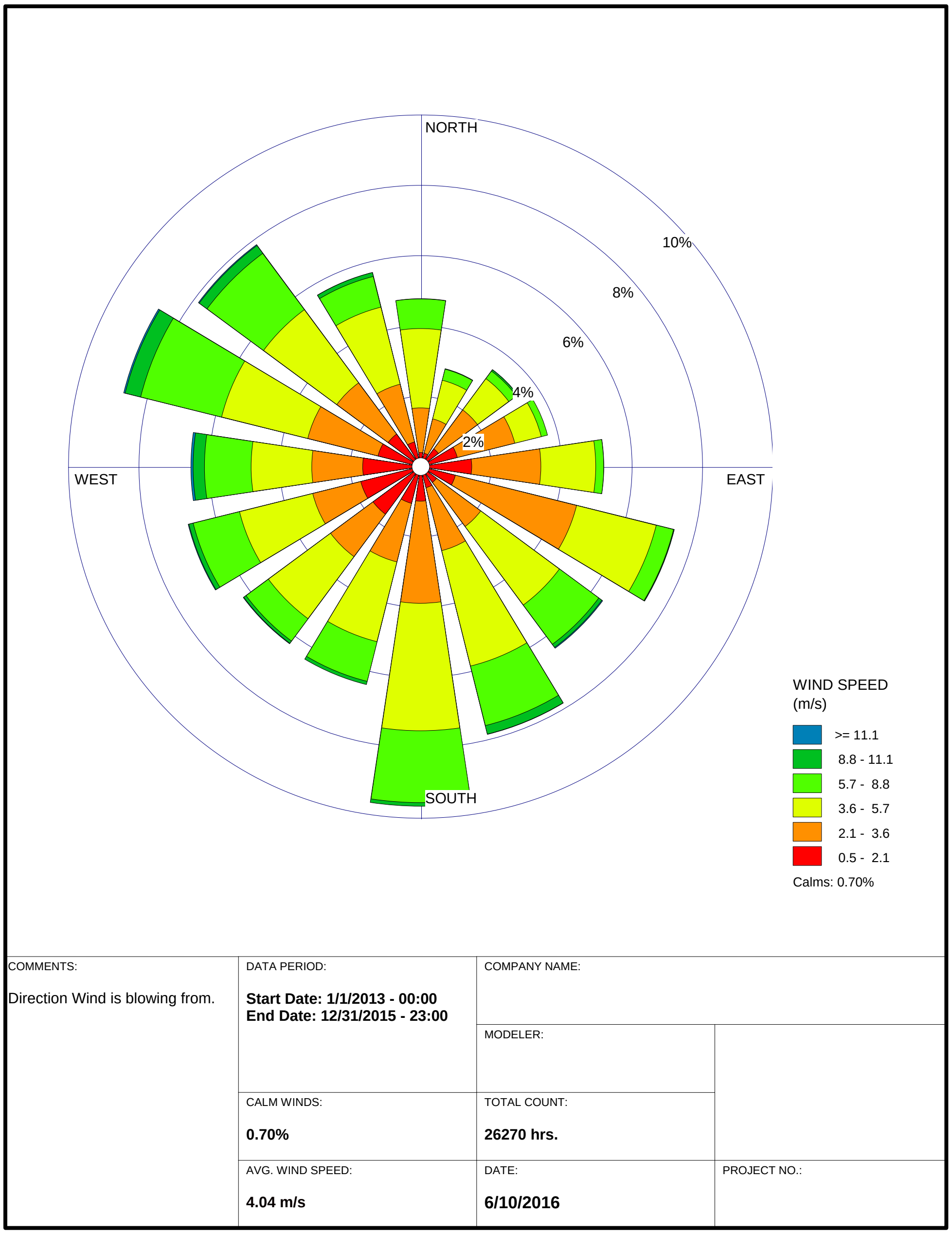
Please refer to Appendix A for a proposed emissions inventory and stack parameters for the DRR facilities. The proposed inventory should be considered preliminary as it is expected to undergo further refinement (and inclusion of the identified background sources) as the data verification process progresses over the coming months.

3.2.4.4 Meteorology

The same meteorological data site selection and processing procedure used for the previous study areas will be applied to the Baldwin and Prairie State Generating Station Study Area. For the Baldwin and Prairie State Generating Study Area, NCDC NWS surface meteorology from St. Louis, Missouri (WBAN No. 13994, 50 miles to the northwest), and coincident upper air observations from Lincoln, Illinois (WBAN No. 04833, 130 miles to the north-northeast), is proposed as reasonably representative of meteorological conditions within the study area.

The three-year surface wind rose for Lambert – St. Louis International Airport (St. Louis, MO) is depicted in Figure 22. The frequency and magnitude of wind speed and direction are defined in terms of where the wind is blowing from, parsed out in sixteen 22.5-degree wind sectors. The predominant wind direction during the three-year time period proposed in the modeling is from the south, occurring approximately 9.6% of the time. The highest percentage wind speed range, occurring 34.6% of the time period, was in the 3.6 - 5.7 m/s range.

Figure 22
Lambert – St. Louis International Airport, Missouri
Cumulative Annual Wind Rose
2013-2015



3.2.4.5 Background SO_2

Illinois EPA expects to incorporate temporally-varying background one-hour concentrations developed from the East St. Louis monitor, which was selected for the study area. The East St. Louis monitor is located approximately 35 miles northwest of the center of the study area in northwestern St. Clair County. The monitor, which is operated and maintained by Illinois EPA, has validated hourly SO_2 concentrations for the three years proposed to be utilized in this analysis (2013-2015). The values developed for input are based on the 99th percentile monitored concentrations and vary by hour and season. A table of the proposed background SO_2 seasonally and hourly varying values to be utilized in the Baldwin and Prairie State Generating Station Study Area modeling is provided in Appendix B.

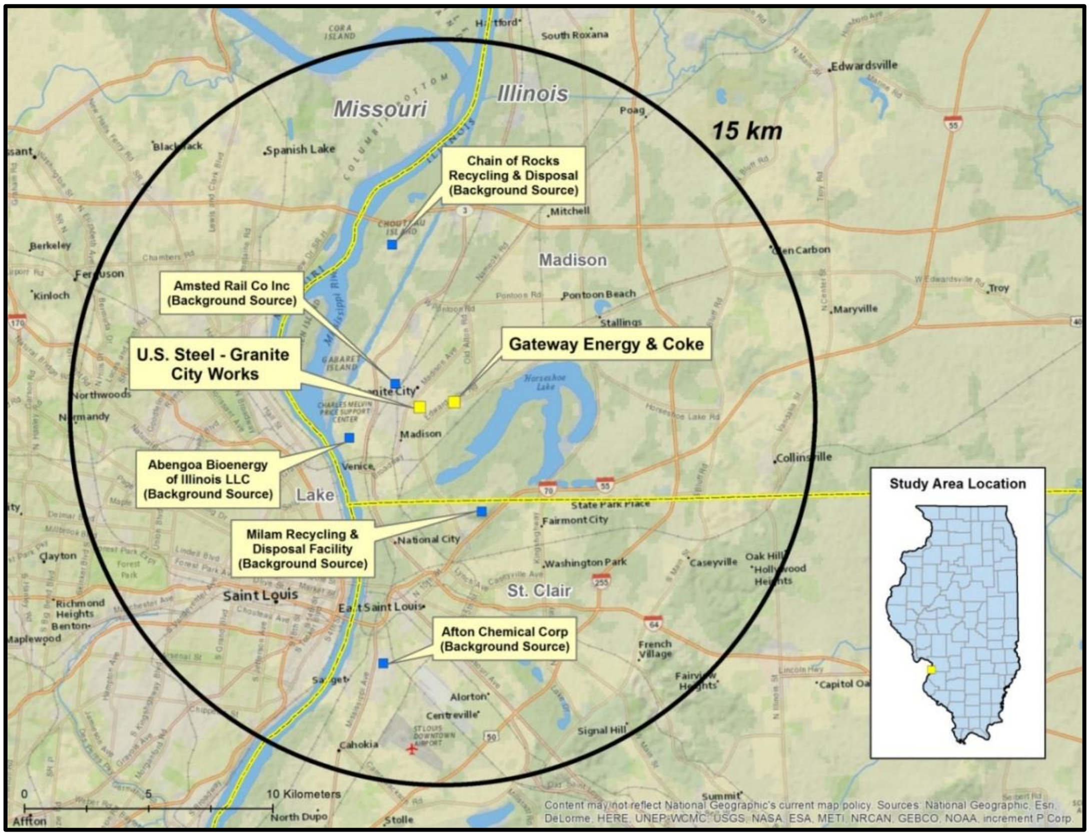
3.2.5 U.S. Steel Corporation/Gateway Energy & Coke Company

The U.S. Steel Corporation – Granite City Works ("USS-GCW") was, until recent time, a fully integrated iron and steel manufacturing facility. In March 2015, the company permanently shut down its coke production operations (Coke Ovens and By-Products Plant), and has since relied exclusively upon external sources to provide a supply of furnace coke. The iron-making (blast furnaces), steel-making (basic oxygen furnaces, continuous casting, reheat furnaces), steel finishing (galvanizing), boiler steam production, and wastewater treatment operations are all sources of SO_2 emissions associated with routine operation of the facility. The Gateway Energy & Coke Company, LLC ("GECC") heat recovery coke plant consists of 120 heat recovery coke ovens that, in total, can produce up to 740,000 tons of furnace coke per year. Waste combustion gases are routed to heat recovery steam generators ("HRSGs") for steam production. The gas stream from the HRSGs is routed to a spray dryer (where lime and water are introduced) and ultimately a baghouse for the removal of both SO_2 and particulate matter. The facility was recently permitted for a Redundant Heat Recovery Steam Generator that will prevent (to the extent practical) the release of emissions through bypass vent stacks. The GECC facility is a source of coke and steam (from thermal recovery) for USS-GCW. As noted earlier, the two facilities are considered to be a single source for the purposes of permitting and this analysis.

3.2.5.1 Proposed Modeling Domain and Receptor Network

The proposed modeling analysis for the USS-GCW and GECC facilities encompasses a circular area extending outward a radial distance of 15 kilometers from a point representing the approximate center of the combined facilities (Figure 23).

Figure 23
U.S. Steel Study Area



Fenceline receptors for both of these facilities and for five background sources (Afton Chemical Corporation; Milam Recycling & Disposal Facility; Amsted Rail Company Inc.; Abengoa BioEnergy of Illinois LLC; Chain of Rocks Recycling & Disposal) along with gridded receptor arrays that encompass these seven facilities will be used in generating predicted ambient concentrations. The proposed receptor network for the study area is as follows:

- 50 meters along the fencelines (USS-GCW, GECC, Afton Chemical Corporation, Milam Recycling & Disposal Facility, Amsted Rail Company Inc., Abengoa BioEnergy of Illinois LLC, Chain of Rocks Recycling & Disposal)
- 100 meter grid from the USS-GCW and GECC fencelines out to a distance of approximately four kilometers
- 500 meter grid from four kilometers out to a distance of approximately 10 kilometers from USS-GCW and GECC

The U.S. Steel Study Area receptor network (see Figure 24) consists of 10,073 receptors, and encompasses portions of Madison and St. Clair Counties. The study area terrain is best characterized as flat to gently rolling. Per the recommendation of the TAD, receptors were not placed on large water bodies (Mississippi River, Horseshoe and Canteen Lakes).

Figure 24
Receptor Grid - U.S. Steel Study Area

3.2.5.2 Auer's Analysis (Urban/Rural Environment)

An Auer's analysis was applied to the U.S. Steel Study Area. Figures 25 and 26 graphically depict the near-field area (three-kilometer ring) and 15-kilometer study area for which the Auer's analysis was conducted. Table 12 provides a statistical breakdown by land cover category for both the three-kilometer ring and 15-kilometer study area.

Figure 25
Land Cover within a Three-Kilometer Radius of USS-GCW and GECC (Urban vs. Rural)

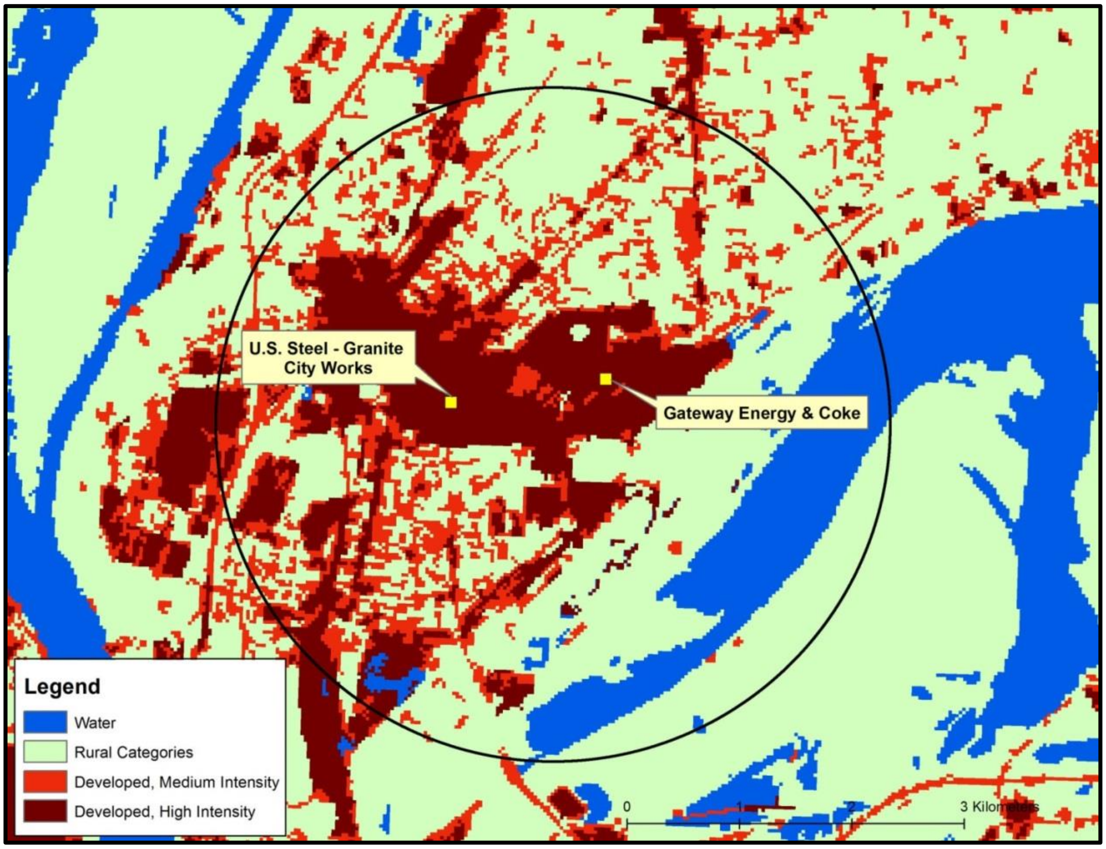


Figure 26
Land Cover in the U.S. Steel Study Area
(Urban vs. Rural)

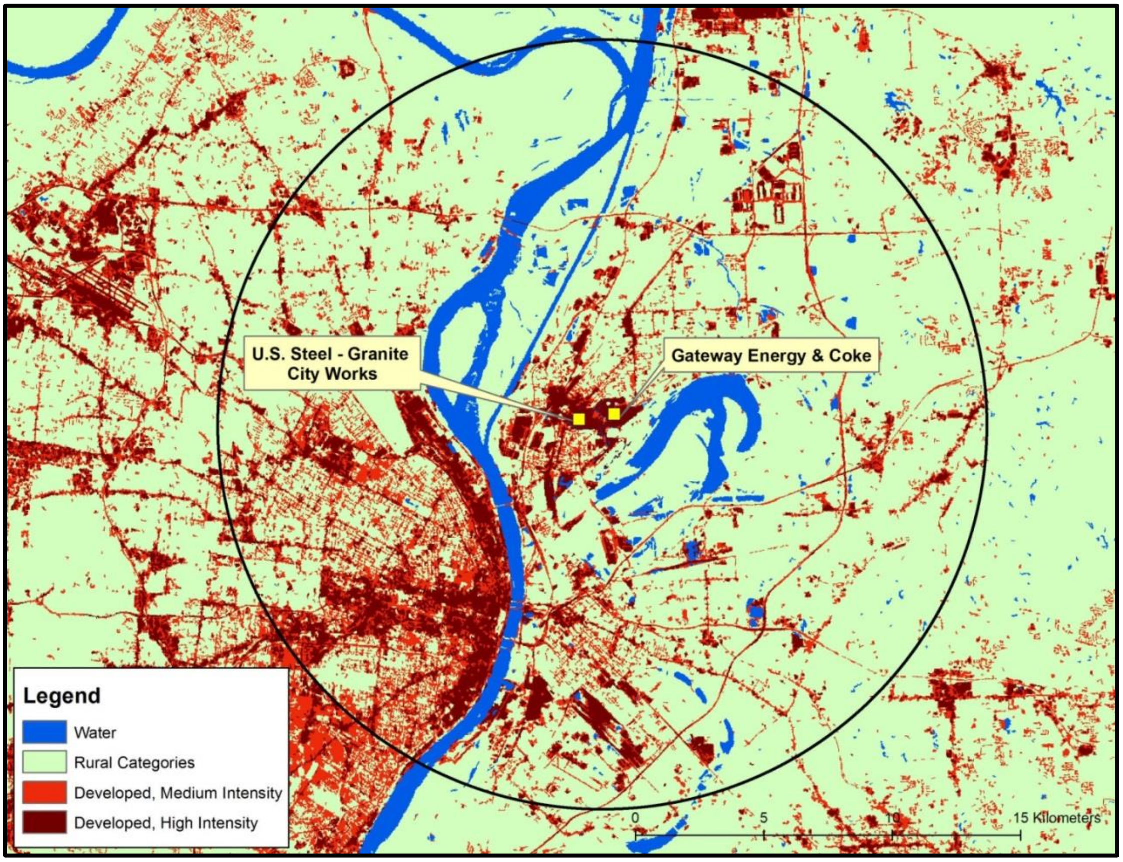


Table 12

Land Cover Percentages by Auer's Category for a Three-Kilometer Radius Area and for the Modeling Domain (15-Kilometer Radius) – U.S. Steel Study Area

U. S. Steel Study Area Auer's Analysis				Auer's 3 km Ring			Study Area 15 km Ring		
NLCD Value	NLCD 2011 Description	Auer's Code	Auer's Class	Cell Count	Percentage	Totals	Cell Count	Percentage	Totals
23	Developed, Medium Intensity	R2/R3	Urban	5,509	17.21%	38.56%	106,411	13.30%	22.06%
24	Developed, High Intensity	I1/I2/C1		6,834	21.35%		70,075	8.76%	
11	Open Water	A5	Rural	3,599	11.24%	61.44%	56,272	7.03%	77.94%
21	Developed, Open Space	A1/R4		2,971	9.28%		108,446	13.56%	
22	Developed, Low Intensity	R1		8,844	27.63%		203,337	25.42%	
31	Barren Land (Rock/Sand/Clay)	A3		0	0.00%		1,574	0.20%	
41	Deciduous Forest	A4		225	0.70%		54,254	6.78%	
42	Evergreen Forest	A4		0	0.00%		12	0.00%	
43	Mixed Forest	A4		0	0.00%		69	0.01%	
52	Shrub/Scrub	A4		0	0.00%		92	0.01%	
71	Grassland/Herbaceous	A3		133	0.42%		1,301	0.16%	
81	Pasture/Hay	A3		65	0.20%		15,527	1.94%	
82	Cultivated Crops	A2		1,475	4.61%		122,910	15.36%	
90	Wood Wetlands	A4		1,805	5.64%		53,882	6.73%	
95	Emergent Herbaceous Wetlands	A3		546	1.71%		5,880	0.73%	
Analysis based on 30 meter by 30 meter raster cells extracted for each area.			*Total*	*32,006*	*100.00%*	*100.00%*	*800,042*	*100.00%*	*100.00%*

The Auer's analysis indicates the study area is at least 77% rural and the three-kilometer near-field area for both plants over 61% rural. Based upon these results, the dispersion regime will be treated as rural.

The 2011 NLCD land cover dataset erroneously classified the vast majority of the USS-GCW/GECC complex as "Open Water." Due to the large areal extent of these two facilities, this classification error significantly skewed the results of the three-kilometer Auer's Analysis. To correct this problem, a small 1700-meter buffer was used to extract out all of the misclassified "Open Water" cells that fell within the property boundaries of the two facilities. From this small grid extraction, it was determined that there were 2,060 cells that were misclassified. The Auer's Analysis results were then adjusted by subtracting the 2,060 cells from the "Open Water" category and adding them to the "Developed, High Intensity" category. This increased the urban land cover percentage from 32.13% to 38.56% for the three-kilometer Auer's Analysis and from 21.80% to 22.06% for the 15-kilometer Auer's Analysis. Despite the increase in the urban land cover percentages, the adjustment did not change the final determination that the U.S. Steel Study Area should be modeled as Rural.

3.2.5.3 Emissions

In response to Illinois EPA's request for operational and emission release information to best simulate actual hour-by-hour stack and fugitive emission releases during a recent three-year period, U. S. Steel staff responded with information for SO_2-emitting sources that included blast furnace operations, the Basic Oxygen Furnace shop, boiler houses, re-heat operations, and steel finishing. The company provided monthly fuel (blast furnace gas, natural gas) or raw material usage quantities and monthly hours of production, which formed the basis of estimated hourly SO_2 emission rates that were also provided. Hourly-specific process exhaust temperatures and flow rates were not available. Illinois EPA will be applying the monthly estimated hourly SO_2 emission rates uniformly to each hour of the particular month, together with specified, invariant values for temperature and velocity. Specific processes or equipment covered include the following: blast furnace stoves, blast furnace casting, blast furnace casting fugitives, blast furnace iron spout, blast furnace flares, blast furnace slag pits, boiler #11, boiler #12, cogeneration boiler, ladle preheaters, slab furnaces, and #8 galvanizing line furnace. The data provided is for years 2012-2014, and a request for 2015 data is still pending with the company.

As of this writing, GECC has not responded to Illinois EPA's request for emission source data to characterize local air quality through modeling. In the absence of having this supplemental information, the Agency will rely upon existing operational, production, emission rate, and emission release information to address the DRR air quality characterization requirement. Existing emission inventory data indicate the following SO_2-emitting sources or processes at the GECC facility: coal charging, coke pushing, main stack (controlled exhaust gas streams), and waste heat stacks.

Total actual emissions reported by USS-GCW and GECC for years 2013-2015 are provided in Table 13, together with annual emission totals for the background sources to be modeled. The magnitude of the emissions of these background sources may individually be several orders (or more) less than those of either USS-GCW or GECC. However, the proximity of these sources and the associated potential for cumulative impacts that may exceed the one-hour SO_2 NAAQS warrants their inclusion. The development of modeling inputs for these background sources, and for which data was not specifically requested, will follow 40 CFR Appendix W modeling guidance and relevant recommendations in the modeling TAD.

Table 13
Facility Actual Emissions – U.S. Steel Study Area

Company I.D.	Facility Name	SO_2 Emissions (tons per year)		
		2013	2014	2015
119813AAI	U.S. Steel – Granite City Works	1,369.5	1,480.3	2,420.9
119040ATN	Gateway Energy & Coke	1,104.2	1,180.1	1,141.0
119465AAG	Abengoa Bioenergy of Illinois LLC	7.8	7.9	7.8
119040AAC	Amsted Rail Co. Inc.	5.9	11.6	13.7
163121AAB	Afton Chemicals	100.6	96.8	98.1
163050AAD	Milam Recycling & Disposal	28.1	28.8	17.4
119801AAK	Chain of Rocks Recycling & Disposal	4.6	4.7	4.8
Total Emissions	**All Facilities**	**2,620.7**	**2,810.2**	**3,703.7**

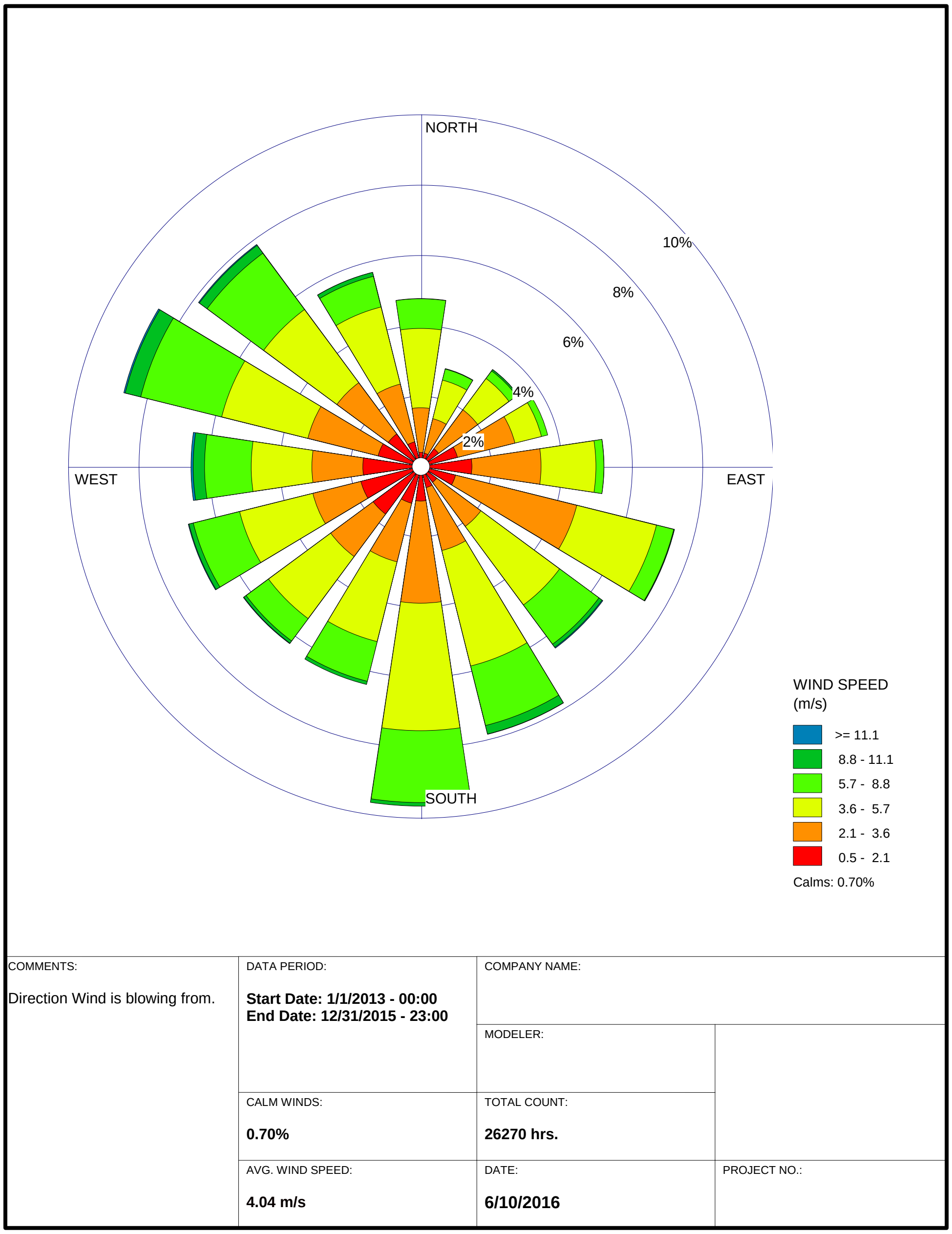
Please refer to Appendix A for a proposed emissions inventory and stack parameters for the DRR facilities. The proposed inventory should be considered preliminary as it is expected to undergo further refinement (and inclusion of the identified background sources) as the data verification process progresses over the coming months.

3.2.5.4 Meteorology

The selection of a representative meteorological station for each of the study areas was based on proximity, similarity of terrain/surface roughness, and climatological consistency. For the U.S. Steel Study Area, NCDC NWS surface meteorology from St. Louis, Missouri (WBAN No. 13994, 13 miles to the northwest), and coincident upper air observations from Lincoln, Illinois (WBAN No. 04833, 106 miles to the north-northeast), is proposed as reasonably representative of meteorological conditions within the study area.

The three-year surface wind rose for Lambert – St. Louis International Airport (St. Louis, MO) is depicted in Figure 27. The frequency and magnitude of wind speed and direction are defined in terms of where the wind is blowing from, parsed out in sixteen 22.5-degree wind sectors. The predominant wind direction during the three-year time period proposed in the modeling is from the south, occurring approximately 9.6% of the time. The highest percentage wind speed range, occurring 34.6% of the time period, was in the 3.6 - 5.7 m/s range.

Figure 27
Lambert – St. Louis International Airport, Missouri
Cumulative Annual Wind Rose
2013-2015



3.2.5.5 Background SO_2

The U.S. Steel Study Area modeling analysis will integrate background concentrations using multiyear averages (2013-2015) of the 99th percentile of monitored concentrations from the East St. Louis, Illinois, ambient SO_2 monitor by season and hour-of-day. The East St. Louis monitor is located approximately 10 miles south of the center of the study area in northwestern St. Clair County. The monitor, operated and maintained by Illinois EPA, has validated hourly SO_2 concentrations for the three years proposed to be utilized in this analysis (2013-2015). To process the data in a manner consistent with USEPA guidance, the second-highest value for each hour of the day during a particular season will be averaged with the corresponding hourly values for the same season represented in the two other years of monitoring data. The hourly by season values will be input to AERMOD via the Source Pathway in the model runstream file. A table of the proposed background SO_2 seasonally and hourly varying values utilized in the U.S. Steel Study Area modeling is provided in Appendix B.

Appendices

Appendix A
Emission Inventories for the Study Areas

Kincaid Study Area Emission Inventory

AERMOD	Source Description	Receptor Location (Meters)		Stack Height	Temperature and Exit Velocity	Stack Diameter	Emissions Profile
Source ID		East	North	(m)	(K and m/s)	(m)	
0007KC	Stack 0007 - Unit 1/Unit 2 Main Stk (Boiler Unit 1-Kincaid)	285609.63	4385297.00	186.84	**See Hourly File**	9.02	A
0001KC	Stack 0001 - Auxiliary Boiler Stack (Gas Fired Kincaid)	285670.58	4385485.58	41.15	**See Hourly File**	1.22	A

A: CEMS Data, hourly varying emissions, temperature, exit velocity

Rain CII Carbon Study Area Emission Inventory

AERMOD	Source Description	Receptor Location (Meters)		Stack Height	Temperature and Exit Velocity	Stack Diameter	Emissions Profile
Source ID		East	North	(m)	(K and m/s)	(m)	
0001RCII	Pyroscrubber #1 Stack	437642.68	4315969.54	45.72	**See Hourly File**	3.4	A
0003RCII	Pyroscrubber #2 Stack	437639.42	4315893.11	45.72	**See Hourly File**	3.4	A

A: Company provided hourly varying emissions and temperature, and invariant exit velocity (from stack tests)

Waukegan Study Area Emission Inventory

AERMOD	Source Description	Receptor Location (Meters)		Stack Height	Temperature and Exit Velocity	Stack Diameter	Emissions Profile
Source ID		**East**	**North**	**(m)**	**(K and m/s)**	**(m)**	**(g/s)**
0018WAU	Waukegan Power Unit #8	430011.73	4692529.25	137.16	**See Hourly File**	4.1	A
0021WAU	Waukegan Power Unit #7	433012.39	4692584.59	137.16	**See Hourly File**	4.3	A
0020WAU	Peaker Stack 1 of 4	432761.42	4692481.37	13.11	672.0/21.64	3.3	B
0069WAU	Peaker Stack 2 of 4	432762.09	4692508.58	13.11	672.0/21.64	3.3	B
0070WAU	Peaker Stack 3 of 4	432788.52	4692508.27	13.11	672.0/21.64	3.2	B
0071WAU	Peaker Stack 4 of 4	432787.89	4692481.06	13.11	672.0/21.64	3.3	B

A: CEMS Data, hourly varying emissions, temperature, exit velocity
B: Hourly Profile of Emissions based on seasonal operation/throughput from Annual Emissions Reports, invariant temperature/exit velocity

Baldwin/Prairie State Generating Study Area Emission Inventory

AERMOD	Source Description	Receptor Location (Meters)		Stack Height	Temperature and Exit Velocity	Stack Diameter	Emissions Profile
Source ID		**East**	**North**	**(m)**	**(K and m/s)**	**(m)**	**(g/s)**
0001BD	Boiler #1 (Baldwin)	249934.19	4232425.13	184.40	**See Hourly File**	5.94	A
0002BD	Boiler #2 (Baldwin)	249931.24	4232363.94	184.40	**See Hourly File**	5.94	A
0013BD	Boiler #3 (Baldwin)	249928.04	4232301.51	184.40	**See Hourly File**	5.94	A
0005BD	Heating Boiler (Baldwin)	250017.08	423244.00	84.12	**See Hourly File**	1.07	B
BALD94D1	Unit 1 Diesel Engine (BD)	250097.51	4232438.59	6.10	**See Hourly File**	0.305	B
BALD95D2	Unit 2 Diesel Engine (BD)	250089.02	4232309.96	2.44	**See Hourly File**	0.2032	B
BALD95D3	Unit 3 Diesel Engine (BD)	250095.66	4232309.96	2.44	**See Hourly File**	0.2032	B
BALD96FP	CH Diesel Fire Pump (BD)	249878.97	4232378.50	6.10	422.04/25.87	0.1524	B
BALD97FP	FD Fire Pump (BD)	250148.71	4232517.89	3.05	422.04/25.87	0.1524	B
0004PS	EP10A Boiler #1 (Prairie St.)	266714.30	4240167.70	213.36	**See Hourly File**	8.53	A
0006PS	EP10A Boiler # 2 (Prairie St.)	266725.10	4240167.30	213.36	**See Hourly File**	8.53	A
26APS	Emergency Diesel FP (Prairie St.)	265934.28	4239947.33	5.94	728.2/58.9	0.1524	C
26CPS	Emergency Diesel Backup Gen (Prairie St.)	266597.55	4239912.50	6.71	762.6/49.1	0.3048	C
0005PS	Auxiliary Boiler (Prairie St)	266583.30	4239848.58	30.48	425.0/20.00	1.52	B

A: CEMS Data, hourly varying emissions, temperature, exit velocity
B: Hourly emissions profile based on data provided by company from monthly fuel usage and monthly operating hours
C: Hourly Profile of Emissions based on seasonal operation/throughput from Annual Emissions Reports

U.S. Steel Study Area Emission Inventory

AERMOD	Source Description POINT	Receptor Location (Meters)		Stack Height	Temperature and Exit Velocity	Stack Diameter	Emissions Profile
Source ID		East	North	(m)	(K and m/s)	(m)	(g/s)
0007	Blast Furnace "A" Stoves	749816.02	4286809.08	70.60	533.2/26.84	2.13	A
0012	Blast Furnace "B" Stoves	749665.50	4286719.93	72.00	533.2/18.56	2.996	A
0011	Blast Furnace Gas Flare #1	749777.33	4286841.02	67.60	1273.0/20.0	4.4	A
0265	Blast Furnace Gas Flare #2	749865.93	4286920.23	67.60	1273.0/20.0	4.7	A
0010	Casthouse Baghouse	749616.61	4286732.18	9.10	338.7/22.52	3.35	A
EPB_1	Emergency Portable Boiler #1	749740.75	4286831.22	11.28	501.0/9.995	0.576	A
EPB_2	Emergency Portable Boiler #2	749740.75	4286831.22	11.28	501.0/9.995	0.576	A
EPB_3	Emergency Portable Boiler #3	749689.82	4286790.38	11.28	501.0/9.995	0.576	A
EPB_4	Emergency Portable Boiler #4	749689.82	4286790.38	11.28	501.0/9.995	0.576	A
0250	Emergency Generator (3500 HP)	749640.25	4286862.11	11.28	501.0/9.995	0.576	A
0150	Blast Furnace 'B' - Iron Spout Baghouse	749831.35	4286818.73	13.10	323.7/13.12	2.39	A
BF010NG	2 Small NG Ovens NIL Emissions in BF Foundry	749711.00	4286514.00	30.00	430.0/11.00	2.0	A
0263	BFG-fired [some NG] Cogeneration Boiler	749776.38	4287803.50	45.70	469.3/18.95	3.1	A
0059	Boiler 11	749865.15	4286883.84	45.72	510.0/21.82	2.44	A
0064	Boiler 12	749881.40	4286887.85	45.72	510.0/13.65	2.44	A
0020	Slab Reheat Furnace #1	747729.70	4286762.02	27.60	616.5/18.96	2.44	A
0195	Slab Reheat Furnace #2	747715.25	4286747.05	27.60	616.5/18.96	2.44	A
0175	Slab Reheat Furnace #3	747700.79	4286730.53	27.40	616.5/18.96	2.44	A
0177	Slab Reheat Furnace #4	747700.27	4286714.00	58.50	781.0/18.11	4.19	A
GECC0021	Coking - New Main Stack	749278.10	4286983.70	60.9607	418.2/14.71	3.96	B
GECC0006	Waste Heat Stack #1	749198.08	4286808.68	25.908	1311.1/21.0	2.74	B
GECC0011	Waste Heat Stack #2	749273.31	4286862.01	25.908	1311.1/21.0	2.74	B

GECC0012	Waste Heat Stack #3	749352.45	4286918.44	25.908	1311.1/21.0	2.74	B
GECC0013	Waste Heat Stack #4	749428.12	4286971.81	25.908	1311.1/21.0	2.74	B
GECC0014	Waste Heat Stack #5	749544.63	4287055.23	25.908	1311.1/21.0	2.74	B
GECC0015	Waste Heat Stack #6	749619.43	4287108.64	25.908	1311.1/21.0	2.74	B
GECC0007	Coke Pushing - A	749619.87	4287112.56	6.1	477.7/21.2	1.52	B
GECC0016	Coke Pushing - B	749545.02	4287058.93	6.1	477.7/21.2	1.52	B
GECC0017	Coke Pushing - C	749428.24	4286976.24	6.1	477.7/21.2	1.52	B
GECC0018	Coke Pushing - D	749352.23	4286921.92	6.1	477.7/21.2	1.52	B
GECC0019	Coke Pushing - E	749273.14	4286865.98	6.1	477.7/21.2	1.52	B
GECC0020	Coke Pushing - F	749197.51	4286811.96	6.1	477.7/21.2	1.52	B
GECC0004	Coal Charging - A	749623.34	4287107.16	7.92	422.2/20.76	1.37	B
GECC0022	Coal Charging - B	749548.49	4287053.91	7.92	422.2/20.76	1.37	B
GECC0023	Coal Charging - C	749432.74	4286971.35	7.92	422.2/20.76	1.37	B
GECC0024	Coal Charging - D	749355.86	4286916.95	7.92	422.2/20.76	1.37	B
GECC0025	Coal Charging - E	749277.43	4286860.70	7.92	422.2/20.76	1.37	B
GECC0026	Coal Charging - F	749201.81	4286807.07	7.92	422.2/20.76	1.37	B

AERMOD	**Source Description Volume/Area**	**Receptor Location (Meters)**		**Volume/Area Height**	**Sigma y**	**Sigma z**	**Emissions Profile**
Source ID		**East**	**North**	**(m)**			**(g/s)**
26140	BOF 4 (Ladle Preheaters Dryers (5))	748400.00	4286320.00	31.75	6.58	14.77	A
CST1	'A', 'B' Blast Furnace Casthouse - Uncaptured Fugitives	749719.33	4286752.50	11.58	4.65	5.39	A
CST2	'A', 'B' Blast Furnace Casthouse - Uncaptured Fugitives	749728.00	4286757.50	11.58	4.65	5.39	A
CST3	'A', 'B' Blast Furnace Casthouse - Uncaptured Fugitives	749736.66	4286762.50	11.58	4.65	5.39	A
CST4	'A', 'B' Blast Furnace Casthouse - Uncaptured Fugitives	749745.33	4286767.50	11.58	4.65	5.39	A
CST5	'A', 'B' Blast Furnace Casthouse - Uncaptured Fugitives	749754.00	4286772.50	11.58	4.65	5.39	A
CST6	'A', 'B' Blast Furnace Casthouse - Uncaptured Fugitives	749762.66	4286777.50	11.58	4.65	5.39	A
CST7	'A', 'B' Blast Furnace Casthouse - Uncaptured Fugitives	749771.33	4286782.50	11.58	4.65	5.39	A

26150	BOF 4 (Ladle Preheaters Dryers (5)	748405.00	4286324.00	31.75	6.58	14.77	A
26160	BOF 4 (Ladle Preheaters Dryers (5)	748410.00	4286328.00	31.75	6.58	14.77	A
26170	BOF 5 (Ladle Preheaters Dryers (5)	748425.00	4286330.00	31.75	4.66	14.77	A
26180	BOF 5 (Ladle Preheaters Dryers (5)	748433.00	4286336.00	31.75	4.66	14.77	A
26190	BOF 5 (Ladle Preheaters Dryers (5)	748440.00	4286343.00	31.75	4.66	14.77	A
26200	BOF 5 (Ladle Preheaters Dryers (5)	748448.00	4286349.00	31.75	4.66	14.77	A
26210	BOF 6 (Ladle Preheaters Dryers (5)	748420.00	4286300.00	31.75	3.06	14.77	A
26220	BOF 6 (Ladle Preheaters Dryers (5)	748425.00	4286304.00	31.75	3.06	14.77	A
26230	BOF 6 (Ladle Preheaters Dryers (5)	748430.00	4286308.00	31.75	3.06	14.77	A
26240	BOF 7 (Ladle Preheaters Dryers (5)	748440.00	4286325.00	31.75	4.66	14.77	A
26250	BOF 7 (Ladle Preheaters Dryers (5)	748448.00	4286331.00	31.75	4.66	14.77	A
26260	BOF 7 (Ladle Preheaters Dryers (5)	748455.00	4286338.00	31.75	4.66	14.77	A
26270	BOF 7 (Ladle Preheaters Dryers (5)	748463.00	4286344.00	31.75	4.66	14.77	A
084A	Slab Cutoff--Caster #1 (Continuous Caster Rm B) and Slab Ripping	748538.31	4286555.96	19.66	4.85	9.14	A
084B	Slab Cutoff--Caster #1 (Continuous Caster Rm B) and Slab Ripping	748545.53	4286549.41	19.66	4.85	9.14	A
084C	Slab Cutoff--Caster #1 (Continuous Caster Rm B) and Slab Ripping	748553.61	4286541.85	19.66	4.85	9.14	A
084D	Slab Cutoff--Caster #1 (Continuous Caster Rm B) and Slab Ripping	748561.63	4286534.42	19.66	4.85	9.14	A
145A	Slab Cutoff-- #2 Caster (Continuous Caster Rm F) and Slab Ripping	748614.68	4286639.00	21.03	5.13	9.78	A
145B	Slab Cutoff-- #2 Caster (Continuous	748622.43	4286631.96	21.03	5.13	9.78	A

	Caster Rm F) and Slab Ripping						
145C	Slab Cutoff-- #2 Caster (Continuous Caster Rm F) and Slab Ripping	748630.33	4286624.94	21.03	5.13	9.78	A
145D	Slab Cutoff-- #2 Caster (Continuous Caster Rm F) and Slab Ripping	748638.32	4286617.63	21.03	5.13	9.78	A
GALA	Galvanizing Lines 7A/8 - Fugitive Emissions	748368.26	4287046.91	31.0	3.75	14.79	A
GALB	Galvanizing Lines 7A/8 - Fugitive Emissions	748374.01	4287041.49	31.0	3.75	14.79	A
GALC	Galvanizing Lines 7A/8 - Fugitive Emissions	748379.56	4287036.28	31.0	3.75	14.79	A
GALD	Galvanizing Lines 7A/8 - Fugitive Emissions	748420.52	4286997.79	11.58	4.61	11.58	A
GALE	Galvanizing Lines 7A/8 - Fugitive Emissions	748428.00	4286990.81	11.58	4.61	11.58	A
GALF	Galvanizing Lines 7A/8 - Fugitive Emissions	748436.60	4286982.91	11.58	4.61	11.58	A
GALG	Galvanizing Lines 7A/8 - Fugitive Emissions	748444.54	4286975.49	11.58	4.61	11.58	A
GALH	Galvanizing Lines 7A/8 - Fugitive Emissions	748451.78	4286968.87	11.58	4.61	11.58	A
GALI	Galvanizing Lines 7A/8 - Fugitive Emissions	748324.79	4287118.60	11.58	4.76	5.38	A
GALJ	Galvanizing Lines 7A/8 - Fugitive Emissions	748331.95	4287112.00	11.58	4.76	5.38	A
GALK	Galvanizing Lines 7A/8 - Fugitive Emissions	748340.34	4287104.30	11.58	4.76	5.38	A
GALL	Galvanizing Lines 7A/8 - Fugitive Emissions	748347.69	4287097.51	11.58	4.76	5.38	A

GALM	Galvanizing Lines 7A/8 - Fugitive Emissions	748354.48	4287091.31	11.58	4.76	5.38	A
GALN	Galvanizing Lines 7A/8 - Fugitive Emissions	748362.29	4287084.18	11.58	4.76	5.38	A
GALO	Galvanizing Lines 7A/8 - Fugitive Emissions	748370.46	4287076.71	11.58	4.76	5.38	A
GALP	Galvanizing Lines 7A/8 - Fugitive Emissions	748378.04	4287069.70	11.58	4.76	5.38	A
GALQ	Galvanizing Lines 7A/8 - Fugitive Emissions	748385.51	4287062.91	11.58	4.76	5.38	A
0126A	Blast Furnace Slag Pits - Slag Spraying	749687.5	4286750.94	5.0	101.0*	10.0/-31.0 *	A

* Area Source with x-dimension, y-dimension, and angle.

A: Hourly emissions profile based on data provided by company, use a "constant" for temperature/exit velocity
B: Hourly Profile of Emissions based on seasonal operation/throughput from Annual Emissions Reports

Appendix B
Background SO_2 Data for Modeling

Nilwood*, Illinois Monitor
Seasonally and Hourly Varying Background SO_2**
<u>Kincaid & Rain CII Carbon Study Areas</u>

Hour of Day	SO_2 Concentration ($\mu g/m^3$)			
	Winter	Spring	Summer	Fall
1	7.68	5.58	5.41	5.41
2	7.50	4.80	5.93	5.50
3	7.68	4.54	4.19	6.37
4	6.89	5.58	6.11	5.32
5	7.68	4.54	5.24	6.28
6	7.59	5.76	6.46	6.37
7	7.59	5.32	6.89	6.28
8	7.50	8.38	8.90	6.81
9	9.07	10.91	9.16	9.77
10	14.75	10.73	9.42	9.16
11	15.44	13.70	10.82	12.65
12	15.09	12.56	9.42	12.56
13	14.13	11.60	7.68	11.78
14	13.52	10.30	8.46	9.51
15	13.52	9.51	8.55	8.46
16	12.04	9.07	6.19	8.64
17	11.43	7.33	5.85	7.77
18	10.12	6.72	5.24	6.72
19	8.20	6.54	4.97	6.72
20	9.51	4.80	4.97	6.37
21	9.60	5.32	4.89	6.46
22	7.85	5.06	4.10	7.15
23	7.50	4.36	4.10	6.54
24	7.68	4.36	4.80	5.93

* Monitor Latitude/Longitude Coordinates: (+39.396075 –89.80974)
** Seasons defined as: Winter (Dec, Jan, Feb), Spring (Mar, Apr, May), Summer (Jun, Jul, Aug), Fall (Sep, Oct, Nov)

Oglesby*, Illinois Monitor
Seasonally** and Hourly Varying Background SO_2
Waukegan Study Area

Hour of Day	SO_2 Concentration ($\mu g/m^3$)			
	Winter	Spring	Summer	Fall
1	5.76	6.63	4.62	5.85
2	6.46	8.03	5.06	5.24
3	5.24	8.20	3.32	4.45
4	5.76	6.72	2.44	4.80
5	6.72	5.76	1.92	7.15
6	6.98	7.15	2.27	7.85
7	6.46	6.28	4.10	6.11
8	7.85	8.46	8.03	5.50
9	9.69	10.91	10.47	6.19
10	12.22	11.52	10.56	9.77
11	12.74	11.95	10.21	11.78
12	14.13	12.91	6.72	10.30
13	15.09	9.95	7.68	8.20
14	15.01	9.95	7.50	8.38
15	12.22	8.03	6.46	7.50
16	11.26	7.24	5.85	6.98
17	10.64	8.46	6.37	7.33
18	9.95	7.42	6.37	7.24
19	9.25	9.77	7.59	4.71
20	8.29	7.85	4.62	7.33
21	8.81	9.16	4.28	7.68
22	7.15	10.38	4.97	6.89
23	6.72	8.20	4.97	4.97
24	6.54	6.72	3.93	5.50

* Monitor Latitude/Longitude Coordinates: (+41.29301 -89.04942)
** Seasons defined as: Winter (Dec, Jan, Feb), Spring (Mar, Apr, May), Summer (Jun, Jul, Aug), Fall (Sep, Oct, Nov)

East St. Louis*, Illinois Monitor
Seasonally** and Hourly Varying Background SO_2
Baldwin/Prairie State Generating Station and U.S. Steel Study Areas

Hour of Day	SO_2 Concentration (μg/m^3)			
	Winter	Spring	Summer	Fall
1	21.73	14.57	7.50	10.56
2	17.28	11.87	18.32	11.08
3	9.60	13.26	17.63	14.40
4	11.26	17.36	12.91	12.13
5	12.13	22.34	13.79	11.43
6	10.38	13.44	10.30	9.25
7	9.60	17.71	11.69	11.43
8	12.83	15.53	19.98	21.81
9	14.48	16.93	31.85	22.95
10	19.98	23.12	27.05	34.29
11	28.53	27.75	24.78	25.83
12	23.03	19.54	19.54	19.89
13	31.32	16.40	18.67	16.23
14	24.26	15.97	17.10	19.98
15	19.02	16.75	15.01	15.71
16	18.15	13.79	17.71	14.22
17	17.89	17.63	12.91	13.79
18	18.06	14.40	13.52	14.57
19	15.71	14.57	10.64	12.48
20	10.38	12.22	9.51	9.16
21	10.56	10.47	14.57	7.07
22	14.83	9.51	9.34	9.86
23	17.54	9.95	8.29	7.24
24	28.10	13.87	8.81	7.94

* Monitor Latitude/Longitude Coordinates: (+38.61203 -90.16048)
** Seasons defined as: Winter (Dec, Jan, Feb), Spring (Mar, Apr, May), Summer (Jun, Jul, Aug), Fall (Sep, Oct, Nov)